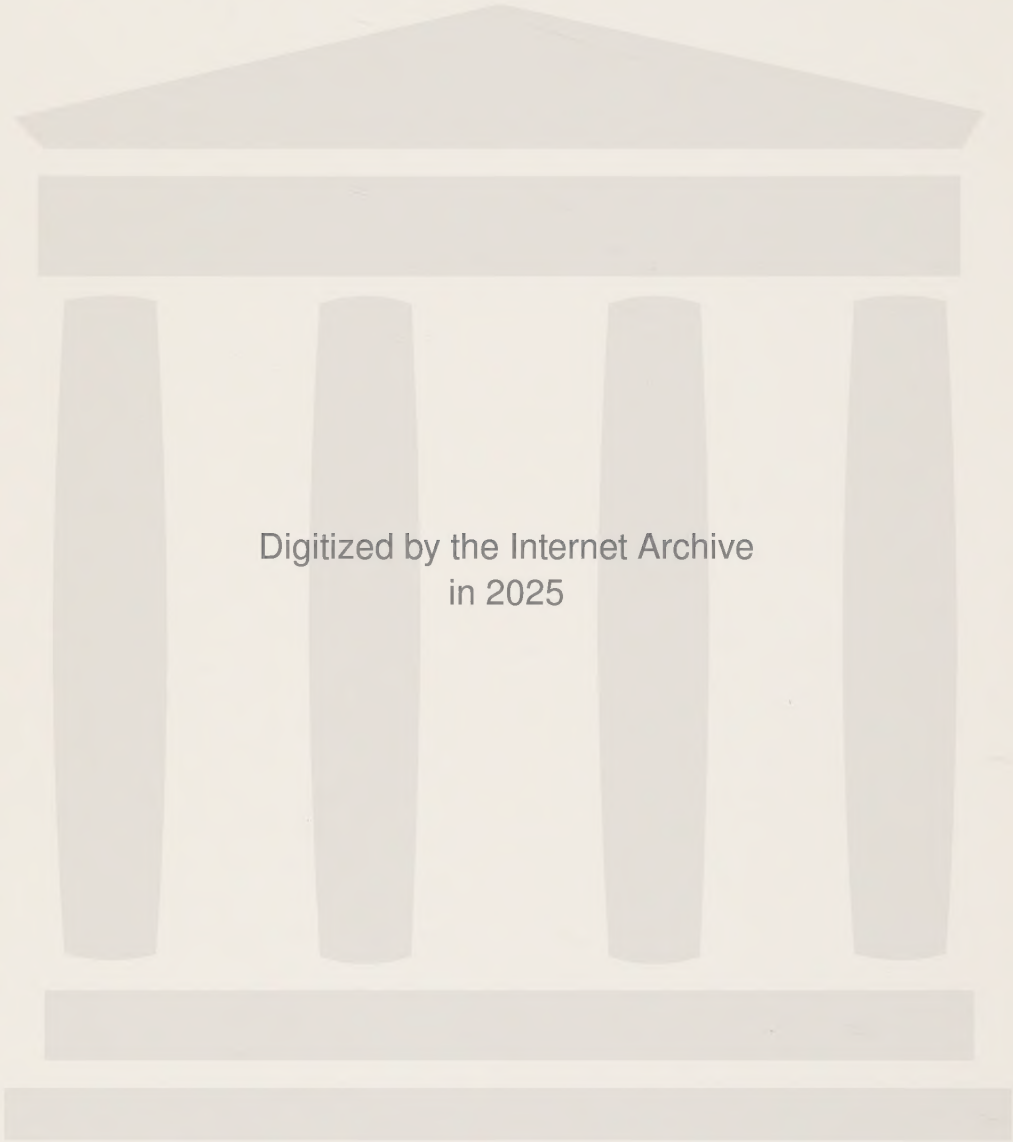
1954 REPORT

EXPERIMENT STATION COMMITTEE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

COMMONWEALTH MYCOLOGICAL INSTITUTE
14 JAN 1955



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THE COMMITTEE IN CHARGE

THE EXPERIMENT STATION
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

REPORT

October 1, 1953 to September 30, 1954

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On the Cover: Tassel control by withholding irrigation water from August 10 to September 20, 1953, at The Lihue Plantation Company, Ltd.

To the President and Members

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

Gentlemen:

We, the Experiment Station Committee, are pleased to submit the Annual Report of the Director for the year 1954. It has been a year of substantial accomplishment along many lines of previously established promise, but a few new areas of endeavor have also been added.

It is a primary function of this Committee to alert the Director of the Station to projects that may be of economic value to the Hawaiian sugar industry. In carrying out this function, the Committee holds a meeting annually on each of the four sugar-producing islands. It also reviews the program of each department of the Station annually, giving priority to the most important projects, approving additional projects, and deleting those no longer important or promising.

We record some of the more important items that have been acted upon during the year. First, and perhaps most important, the Committee has approved in principle a program for making research into the organic chemistry of sugar and its by-products a permanent part of the Station's experimental program. The first step in this new field is an agreement with The Imperial College of Tropical Agriculture, Trinidad, B. W. I. As this is being written, Dr. Baver is on a trip that will take him to Trinidad where he will go over with Dr. L. F. Wiggins, Director of Sugar Research, the projects in this new field of endeavor that are to be studied by the scientist assigned to Hawaiian by-products. As we go further into the field of organic by-products, it is quite possible that more and more of the research will be carried on here in Hawaii, with additions to the Station staff.

Other phases of by-products research include the Executive Committee's action in setting up the Economic Study Committee which will investigate the commercial possibilities of projects that show promise of economic success, once the primary research has been completed. In the past year, several promising possibilities have been referred to this Committee.

As a part of the by-products research program, an agreement was made with Stanford Research Institute for the study of cane bagasse as a low-grade aggregate in cement products.

In another area of research, a cooperative experiment with Ionics, Incorporated and Godchaux Sugar Refining Company, in the use of a membrane for molasses and

cane juice demineralization, was carried through its elementary research phase with promising results.

In Meteorology, the HSPA agreed to extend to January 1956 the research program in the seeding of warm clouds carried jointly with the Pineapple Research Institute and the Hawaiian Irrigation Authority.

During the year, the Station has had the services of Dr. Samuel Price, cytologist from the United States Department of Agriculture, who is making chromosome counts on various commercial cane varieties and breeding canes with the object of assembling information which may aid in planning the breeding program. We have also had the cooperation of Robert Coleman, plant physiologist, USDA, who is investigating the physiological aspects of the sugar cane plant with special reference to the initiation and inhibition of tasseling. We record with considerable satisfaction our increasing cooperation with the USDA.

Beginning September 27, 1954, the Station and the Pineapple Research Institute obtained the services of Dr. W. T. Federer, Professor of Biological Statistics, who is on sabbatical leave from Cornell University, to head our Experimental Statistics Department.

It is with deep regret that we record the passing of Ralph J. Borden, Head of the Experimental Statistics Department. He had been with the Station since 1932.

In closing, we should like to acknowledge the assistance of the Island Associate Members who have helped bring the research program closer to plantation needs, and of the Technical Advisory Committees who have guided the research program on much that we record here.

Respectfully submitted,

THE EXPERIMENT STATION COMMITTEE, HSPA

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To the Experiment Station Committee

Gentlemen:

It is a pleasure to submit to you the Annual Report of the Experiment Station for the year ending September 30, 1954.

This has been another year of excellent teamwork between the various departments of the Station and plantation personnel. Progress is being made in every area of sugar cane production and raw sugar manufacture.

The cutter-transport unit has been a significant contribution by the Department of Agricultural Engineering to the problem of cane harvesting. It has performed well under wet conditions on sloping terrain on the Hamakua and Hilo coasts. At least two units are being planned for plantation operation. Significant progress has been made toward a more positive pickup mechanism for cane harvesters.

An irrigation seminar, held at the Station during October 1953, was well attended by industry personnel. The discussions proved most stimulating to a stepped-up irrigation research program. R. B. Campbell joined the staff of the Department of Agronomy to head up all the basic soils work related to irrigation. E. M. Norum is handling the engineering aspects of flume design, outlet discharge, etc. Infiltration measurements and water distribution studies are pointing the way to improved irrigation practices and a more efficient use of water.

Compaction studies by the Department of Agronomy staff have been carried out in such detail that the basic information being obtained is perhaps the most extensive of its kind in the world. The results are having a profound effect upon plantation operations.

Soil improvement investigations, which have proved their great worth on heavy clay soils, are being extended to sandy areas to determine the effect of organic matter on more efficient water utilization. Preliminary observations appear very encouraging.

Soil tests for phosphorus, potash and calcium have been made on thousands of samples to help chart the fertilizer recommendations for a given field of cane. Phosphorus analyses, especially, are contributing significantly to better phosphate fertilization on a large number of plantations.

The harvesting of the fertility experiments, made cooperatively with American Factors plantations, has produced excellent basic information for correlating plant and soil analyses with cane and sugar yields. Alchohol-soluble or total nitrogen of the stalk as developed by the Department of Physiology and Biochemistry appears to offer a more reliable index of nitrogen fertilization than is furnished by the leaf nitrogen values now being used.

Radioisotope investigations now cover a wide field, ranging from the use of radioactive carbon in the study of sugar manufacture by the cane plant, to radioactive isotopes used for determining nutrient absorption by plants, the distribution of water in the irrigation furrow, the moisture content of soils, the weighing of bagasse in the mill, the continuous integration of temperature and sunlight energy in meteorological studies, and the effect of radiation in the breeding of cane.

Important cooperative experiments on the causes for the decline of yields of cane varieties were initiated at Oahu Sugar Company and Hamakua Mill Company. The former will compare H109 and 37–1933; the latter will compare 32–8560 and 44–3098.

It has been fairly definitely established that ratoon stunting disease is present throughout the Hawaiian Islands. In only a few cases has it been observed widely in plantation fields. Long hot water treatment has proved effective in destroying the internal symptoms of the disease. Disease-free seed areas are being planted on most plantations.

The cooperative investigations with the United States Department of Agriculture on cane cytogenetics and the physiology of flowering of cane were inaugurated with the appointment of Dr. Samuel Price to the staff of the Sugar Crops Section, USDA, at Beltsville, Maryland, and the transfer of Robert Coleman from Houma, Louisiana, to Honolulu.

The HSPA inhibitor of corrosion, developed by the Department of Chemistry, is proving to be outstanding in preventing corrosion in TCA solutions as well as in salt solutions. It also hinders the decomposition of PMA solutions. It is hoped that the patent situation will be clarified soon, so that the Station will not have to continue to assume the complete responsibility for its distribution to plantations.

The results from by-products research continue to be rather promising. Several plantations are exhibiting keen interest in the production of livestock feed and the pen-fattening of cattle. The economic report on the production of 9-point corrugating medium will soon be available. Two new areas of cooperation have been opened. The Stanford Research Institute at Palo Alto, California, has contracted to study the possibilities of lightweight concrete aggregates. The Imperial College of Tropical Agriculture, Trinidad, British West Indies, through Dr. L. F. Wiggins, will investigate the industrial chemical possibilities in filter cake and bagasse.

W. P. Alexander, formerly manager at Grove Farm, was appointed Principal Coordinator of Training of Personnel to succeed the late J. Douglass Bond. Modern screening devices are being employed in the selection of trainees, and increased efforts are being made to improve the quality of training.

Dr. C. E. Pemberton, Principal Entomologist, and A. K. Hansen, Senior Design Engineer, retired at the close of 1953. A. R. Lamb, Associate Biochemist, retired in 1954. R. H. Van Zwaluwenburg was promoted to Principal Entomologist. E. C. Zimmerman resigned as Associate Entomologist, and J. W. Beardsley, Jr. was appointed Assistant Entomologist. G. S. Palmerton was appointed Assistant Mechanical Engineer in the Agricultural Engineering Department.

The Experiment Station mourns the loss of Ralph J. Borden, Principal Statistician, and Pedro Victoria, Drafting Technician, in the Department of Experimental Statistics, who died suddenly within two weeks of each other. They are missed by the Station, both personally and professionally.

During the year, 693 volumes were added to the Library, of which 60 were gifts and 295 were returned from the bindery. There were 1648 books loaned from the Library, of which 294 were borrowed by others than staff members.

All staff changes taking place during the year are listed on page 80.

Respectfully submitted,

L D Baver

Director

BY-PRODUCTS

CHICKS AND HENS RESPOND TO FINAL MOLASSES RATIONS

Cooperative tests between the Department of Poultry Husbandry of the Hawaii Agricultural Experiment Station, the Experiment Station, HSPA, and the Sugar Research Foundation, have proved that both growing chicks and laying hens can utilize much higher amounts of final molasses in the ration than is generally recognized. Optimum levels of final molasses appeared to range from 7.5 to 23.0 per cent for growing chicks, and from 6.8 to 13.6 per cent for laying hens. These concentrations gave more profitable production than control rations containing no molasses.

FINAL MOLASSES PRODUCES GOOD BEEF PROFITABLY

Cooperative experiments between the Department of Animal Husbandry of the Hawaii Agricultural Experiment Station, the Experiment Station, HSPA, and IRAC, on the pen-fattening of Hereford steers have shown that steers can be fattened profitably with a final molasses ration. About 626 pounds of total digestible nutrients were required per 100 pounds of gain. The average daily gain was 1.95 pounds per animal. Feed cost per 100 pounds of gain was $17.46. This permitted a profit of $5.82 over feed costs. The meat was firm and tender with excellent marbling, good texture and color.

ECONOMIC STUDIES IN PROGRESS FOR DECISION ON 9-POINT PRODUCTION

Additional data from the Crown Zellerbach Development Laboratory have confirmed previous findings on the superior quality of Hawaiian bagasse for the production of 9-point corrugating medium used in making shipping containers. A thorough economic study of the manufacturing process is nearing completion. This report will serve as a basis for making decisions relative to either the construction of pilot plant facilities for 9-point production in the Islands or to the postponement of such decision until the economic picture is more favorable.

DEPITHING BAGASSE IMPROVES QUALITY OF PULP

Cooperative studies with the Crown Zellerbach Development Laboratory at Camas, Washington, have consistently shown that higher quality pulps are produced from bagasse if most of the pith fraction is removed. (Figure 1) The presence of excessive pith reduces yield, tear resistance, tensile strength, folding endurance, resistance to burst (Mullen), brightness and freeness. Pulp from whole bagasse was from four to six times as hard to dewater as that from depithed bagasse. Chemicals required for both pulping and bleaching are increased when the bagasse contains pith. There is more dirt in the pulps from whole bagasse than in the pulps from depithed bagasse.

PULP FROM LEADING VARIETIES SIMILAR

Pulping experiments at the Crown Zellerbach Development Laboratory have shown that depithed bagasse from varieties 32–8560, 37–1933, 38–2915 and 44–3098 produced pulp very similar in quality. There were only minor variations. Variety 38–2915 gave slightly inferior tear and burst values. Growing conditions had as great an effect on pulping characteristics as variety.

Figure 1. Depithed bagasse, shown at the right, is superior to whole bagasse for paper.

BAGASSE PULP BLEACHES EASILY

Cooperative investigations at the Crown Zellerbach Development Laboratory have shown that bagasse pulp cooks easily with the kraft process to a low bleach demand, requiring less chemicals than softwood kraft pulps. Dirt in the bagasse presented a serious problem in the bleaching operation. Considerable progress has been made in dirt removal methods.

BAGASSE CAN BE PULPED WITH SODA

The standard soda process produced a bagasse pulp only slightly inferior to that produced by the kraft process. Crown Zellerbach technicians observed that with proper adjustments, neither cooking time nor cooking temperature was a critical pulping factor.

CANE LEAVES AND TOPS LOWER PULP QUALITY

The presence in bagasse of cane leaves and tops results in a pulp with decreased strength and inferior drainage properties. These data from the Crown Zellerbach Laboratories call attention to the importance of removing as much dirt and trash as possible from the cane during harvesting whenever the bagasse produced is to be used for paper purposes.

HARDBOARD REPORT SUGGESTS FUTURE POTENTIALS

Excellent hardboards can be made from bagasse by both wet and dry process methods. However, due to the small size of the Hawaiian market and to present competition on the mainland, it is not economically feasible to produce hardboard in Hawaii at this time. Estimates suggest enough increased mainland demands for hardboard by 1960 to warrant a restudy of the market structure in 1957.

HAWAIIAN FILTER CAKE POOR SOURCE OF CANE WAX

A survey of filter cake from Hawaiian sugar cane plantations has indicated that it is not only lower in average crude wax content than that from other cane areas, but is also lower in the percentage of hard wax present. This low percentage of hard wax places Hawaiian wax in an inferior position compared with wax from many sugar cane areas.

Preliminary observations indicate, however, that

Figure 2. These four finished reports show the progress made in by-products research.

the hard cuticle wax knocked off the cane in the cleaning plant may offer a good source of high-quality wax. Further research is under way to explore this possibility.

FURFURAL PROSPECTS POOR

Increased consumption of furfural has prompted a detailed study of the cost picture. Existing commercial methods for manufacture, however, are not economically feasible for bagasse in Hawaii. Market prices currently prevalent are restricted by strong competition from other chemicals. New plant installations must bear inordinately high construction costs in turning out a relatively low-price chemical.

Better processing methods with lower capital investments are necessary for a successful bagasse-furfural undertaking.

AMMONIA REPORT ISSUED

A study of the possibilities of manufacturing anhydrous ammonia from fuel oil in Hawaii has shown that such an operation would be economically feasible if the pineapple and sugar industries would commit themselves to its use. The Station's interest in anhydrous ammonia has had the indirect effect of lowering the price of nitrogen imported from the mainland as aqua ammonia.

NEW COOPERATIVE VENTURES IN BY-PRODUCT RESEARCH

Two new avenues of research were opened during the year to obtain additional knowledge for the industrial utilization of cane by-products. A contract executed with the Stanford Research Institute, Stanford, California, set in motion an investigation of the possibilities of making lightweight concrete from cement and bagasse. An agreement also has been reached with The Imperial College of Tropical Agriculture, Trinidad, British West Indies, to study the organic chemistry of bagasse and filter cake, looking toward industrial possibilities in the chemical field.

CULTURAL PRACTICES

AQUA AMMONIA—THE FIRST MAJOR CHANGE IN NITROGEN FERTILIZATION IN TWENTY YEARS

The marked price advantage which aqua ammonia holds over the other nitrogen fertilizers resulted in a rapid shift to the liquid fertilizer.

Studies in the use of aqua ammonia involve applications in irrigation water and by injection equipment on unirrigated plantations.

Since large acre inch applications of water are required where distribution of irrigation water is poor, studies were initiated to check the vertical distribution of ammonia applied in irrigation water. With normal irrigations in low humic latosols, practically all of the 60 pounds per acre nitrogen applications were found in the top six inches of soil. None was detected below one foot. Investigations are continuing to check the subsequent losses by leaching after conversion to water-soluble nitrate nitrogen.

Placement studies showed losses of nitrogen to be relatively high with surface applications of ammonia, but very small with placements an inch beneath the soil surface. This was true whether the soils were in the air-dry or moist condition.

Similar studies of losses of nitrogen from ammonium sulfate by volatilization showed negligible losses in acid-to-neutral soils. In alkaline soils, with free coral, the losses increase. Representative data are as follows:

Plantation	pH	Per cent loss
Paauhau	5.2	0.1
Kohala	5.5	0.2
Makiki	7.3	0.3
Grove Farm	7.8	4.2

Critical field examinations have been made where aqua ammonia has been applied in irrigation water. No pronounced areas of nitrogen shortage have been observed. The increasing rates of nitrogen fertilization may possibly preclude finding symptoms of nitrogen starvation. If this reasoning is correct, it is logical to assume that excesses of nitrogen may be found in sections that receive more than their proportion of water.

Considerable difficulties have arisen in the testing of aqua ammonia applied by injection equipment on the unirrigated plantations. The tests to date, however, show no reasons why this cheaper form of nitrogen cannot be used.

TAGGED NITROGEN EXPERIMENTS YIELD IMPORTANT DATA

An important tagged nitrogen (N15) experiment has been completed. Six single-stool ratoon plots were given 180 pounds of N and harvested at 18 months of age. Of these, stool No. 1, which received all the N in a single application, was studied in detail, including roots and residual soil. A summary is given in Table I. Very striking are the following results:

1. 32 per cent of the fertilizer N was recovered in the plant instead of the usually accepted 50 per cent.

2. Of the fertilizer taken up, 40 per cent had been discarded in the dry leaf trash before harvest. This equals the amount in the top and stalks at harvest.

3. The upper 18 inches of soil still held 60 per cent of the fertilizer N after 18 months. This means that there was very large interchange with soil N, probably through microbial action.

Another striking result was that a spread of six months in time of application did not measurably affect the amount of fertilizer N in the leaves at 18 months of age.

Table I
Distribution of Recovered N15 in a Stool of Cane—18 Months Old

Stool I Variety: 37–1933	Per Cent of Dry Weight	Mol Per Cent N15 Excess	N15 Recovered Mg.	Per Cent of Total Recovered
Tops and Stalks	61.56	.060	10.57	39.94
Preharvest Trash	25.43	.176	10.84	40.95
Stubble	2.74	.060	0.89	3.35
Roots	10.27*	062	4.17	15.75
Total	100.00		26.47	100.00

N15 added to soil = 82 Mg. N15 recovered in plant = 32% N15 remaining in top 18″ soil = 61%

* Mr. Borden's chart was used as a guide in arriving at estimate for root mass.

SIGNIFICANT FACTS ON PHOSPHORUS OBTAINED

Studies on phosphorus metabolism have gone ahead rapidly this year. The effects of temperature on P uptake are shown in Figure 3. In addition to this type of study, many analyses have been made on field samples, especially in areas where soil P is low enough to limit yields, i.e., added fertilizer P increases yields. Statistical analysis of the levels of P found in blades, sheaths, and stalk internodes has established that the stalk parts are better indicators of P utilization.

Table II summarizes the ranges of P found in the 8–10 internodes and gives a preliminary estimate of the critical level, below which yield responses can be expected.

Table II

Total P in Internode 8–10	Plant Response
Below 0.031	A yield response may be expected if P is added to soil and absorbed by the plant.
0.034	Cane at Pepeekeo had received 400# P_2O_5 and was growing well.
0.037 0.065	Adding P to soil may increase P in plant but yield differences will probably be insignificant.
Over 0.100 (and probably over 0.065)	Adding P to soil probably will not increase P in plant and will give no gain in yield.

Therefore critical level for P in internodes 8–10 is 0.031–0.034.

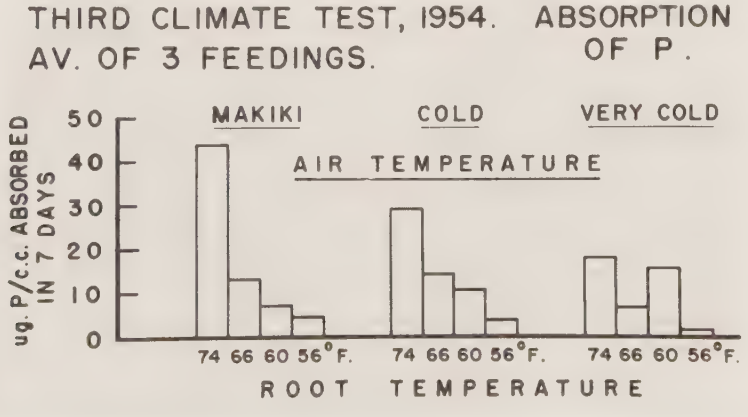


Figure 3. The effects of air and root temperature on absorption of phosphorus from culture solution are large.

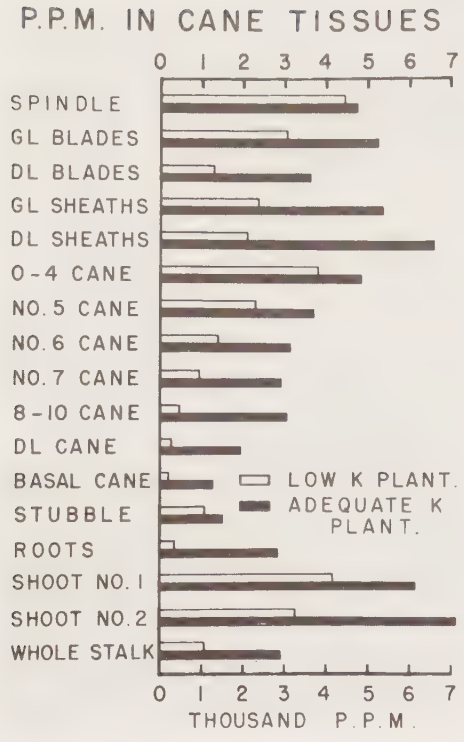


Figure 4. The mature stalk and the older foliage are far more sensitive to potassium deficiency than are the younger green foliage and the elongating green stalk.

POTASSIUM DISTRIBUTION VARIES WITHIN PLANT

Figure 4 shows the relative sensitivity of plant parts to potassium deficiency. In a plant which had received one-third of normal K, the spindle and growing tip were scarcely affected. The older foliage is more affected than the younger. The maximum differences are found in the roots. Of the above-ground portions, the most sensitive are the older cane parts, beginning with the 8-10 internodes.

RADIOACTIVE CARBON MEASURES PHOTOSYNTHESIS

Radioactive carbon is being used by the Department of Physiology and Biochemistry to measure photosynthetic rates in the field. Spot measurements are being expanded to test the carbon-fixing power of leaves of all ages at different moisture levels and under different nutritive conditions.

RADIOISOTOPES SHOW HOW CANE MAKES SUGAR

Tagging of leaves with P32 and C14 is being continued in a study made by the Department of Physiology and Biochemistry of the metabolic intermediates of cane leaves. It seems clear that in sugar cane, phosphoglyceric acid (PGA) is not the major carrier of newly-fixed carbon that it is found to be in some algae. Other compounds are much more richly tagged very early in the cycle of photosynthesis, and their identification is of considerable importance in clarifying how the process goes in sugar cane as contrasted with algae.

THE AIRPLANE REPLACES THE MULE

Harvesting data of recent tests and the vigor of treated fields have resulted in a burst of air activity in fertilization on many of the unirrigated plantations. In the first eight months of 1954, over five

and one-half million pounds of fertilizer, urea and granular muriate of potash, were applied by airplane on 24,000 acres of cane.

Stalk census studies in field cane 20 to 24 months old revealed marked improvements in tonnage and condition of the secondaries where second-season fertilizer had been applied. The increased yields from the application of second-season fertilizer are unquestionably due to a prolonged period of high cane productivity prior to maturity.

Intensive pattern distribution studies have shown that Murrayair's planes, with their new fertilizer distribution units, are doing a commendable job in fertilizer application.

Studies were undertaken to determine how early in the life of the cane plant broadcast applications of N-K fertilizer could be effectively utilized. When cane is sufficiently developed to have three feet of stalk to the last visible dewlap, the root systems will be interlocking to such a degree that leaching losses would be kept at a minimum. This would permit the third application of fertilizer to be put on by air after the cane is too large for machine application or for effective hand fertilization.

NUTRIENT DEFICIENCY SERIES ANALYZED

Four varieties, 32–8560, 37–1933, 38–2915, and 44–3098, were grown in a complete solution and in solutions without sufficient Fe, Ca, Mg, Mn, B, K, and N, to maintain normal growth. After specific symptoms of distress were well developed, the plants were harvested and divided into blades, sheaths, immature stalks, and mature stalks.

Complete analyses were made by the spectograph to check the deficiency levels in the different parts of the cane plant. Deficiency series also included Zn, Mo, and Co; but even though extreme precautions were taken, the plants obtained enough of these elements from the seed so that marked deficiency symptoms did not develop.

With a knowledge of deficiency levels, subnormal field samples can now be analyzed and guides for future treatments can be obtained to insure *balanced nutrition*.

CROP LOGGING TECHNIQUES UNDER CRITICAL REVIEW

Comprehensive studies in the evaluation of crop log procedures have continued. Special Release No. 88, covering crop logging at Hawaiian Commercial & Sugar Co., Ltd., has been published.

Cooperative studies with the American Factors plantations and with Olokele Sugar Company are being conducted in order to determine critical nutrient levels in the plant, as well as to investigate possible improvements in the crop logging technique.

THE SOIL FACTOR IN NUTRITION STUDIES

Critical Levels of P, K and Ca in Soil

Dozens of new experiments have been studied in the continuing efforts to define critical levels for modified Truog P and exchangeable K and Ca.

Phosphorus

The critical level for this element on low volume weight soils still appears to be in the vicinity of 20 ppm. It is somewhat lower for the high volume weight soils owing to the greater mass of soil available to the plant roots.

Over 3000 soil samples were sent in during the first eight months of 1954 from 23 plantations. The data from the analyses of these samples were used to determine the need for phosphate fertilizers. In addition, several plantations are now analyzing their own soil samples.

Potassium

For the high volume weight soils, for which the critical level for this element has been established, responses at levels of K above 100 ppm are rare. From this point down to 75 ppm, response is uncertain, while below 75, it is usual. Without exception, responses were obtained in all of the 24 tests containing 65 ppm or less of K. There are indications that on the low volume weight soils and in

rocky and shallow areas, the critical level for K may be above 100 ppm.

The ability to retain KCl against leaching has been found to be largely a function of the degree of base saturation of the soil. Progressively liming unsaturated soils correspondingly increased retention of KCl. Conversely, desaturation of soils with excellent KCl retentive power greatly diminished their capacities in this respect.

Calcium

The results of 12 experiments suggest that the critical level for calcium is in the vicinity of 100 ppm.

Effect of Cropping on Nutrient Levels in Soil

Phosphorus

In the absence of phosphate fertilization, the level of soil phosphorus declined 5.5 ppm on the average as the result of the production of a single crop of cane. The figure is based on results of 30 experiments. For the Hilo and Hamakua Coast tests, the decrease was related to the initial level of P, the drop being greater when the initial level was higher.

With normal phosphate fertilization, a significant relationship was also established. Here, however, decreases were much smaller. In fact, at the lower levels there is little evidence that a measurable change in P occurs.

Potassium

The effect of cropping upon the level of soil K, in the absence of added potash, was found to be greater the higher the initial K level. This statistically significant relationship shows, for example, that at the critically low K level of 60 ppm the decline, coincident to the production of a crop of cane, is only about 15 ppm. At 200 ppm, the corresponding decrease is 100 ppm.

Ratoon Sampling—Line vs. Kuakua

In cooperation with a number of the plantations, a study has been made of the feasibility of supplementing phosphorus data obtained by interrow sampling with that secured by sampling in the line.

The results show promise of furnishing a semi-quantitative measure of phosphate residues remaining from the fertilization of preceding crops in the same cycle. The results are very difficult to interpret where rock phosphate, or underacidulated rock, has been localized in the line.

CONTROLLED CLIMATE HOUSES PRODUCE INTERESTING RESULTS

The climate houses were modified this year by substituting for the warm house (90° F. above Makiki temperature) a very cold house (18° F. below Makiki). The three air temperatures are Makiki, M–9° and M–18°. The four root temperatures are 74°, 66°, 60°, and 56°. The small steps in root temperature are expected to fix rather closely the temperature limit for root activity.

Figure 5 shows the very cold chamber which has accumulated no day-degrees, except for a single day when a fuse blew. A preharvest estimate of a growth rate approximating 50 per cent of the Makiki controls points to the desirability of a new day-degree as a measure of potential sugar cane growth.

Again it appears that a major factor in the limitation of growth by cool roots is insufficient water supply. The lower the root temperature, the more severe the wilt each day, and the decreased water demand in the cold air increases the tolerance to low root temperature.

The uptake of other nutrients follows closely the picture for nitrogen described in earlier reports. Figure 3 shows the generally regular step-wise effects of changing air and root temperatures on uptake of phosphorus from culture solutions.

In the climate houses, a third check is being made on the effect of air and soil temperature on water uptake by sugar cane. The crop is not yet harvested, but preliminary estimates support the earlier statements that water consumption closely parallels growth, i.e., in water culture, a definite amount of water is required for each gram of tissue and sugar made.

Figure 5. In this house, the air temperature is 18° below Makiki air. The substantial rate of growth at this low temperature suggests the need for a new day-degree as a measure of potential sugar cane growth.

SOIL IMPROVEMENT STUDIES EXPANDED TO SANDY SOILS

Sandy spots in fields have, in the past, required special treatments in irrigation and fertilization to produce reasonably satisfactory yields. Sandy soils have a low water-holding and base-exchange capacity.

Preliminary results obtained at Kahuku Plantation Company and Wailuku Sugar Company show marked improvement in the sandy soils after treatment with organic materials. The added cane trash and bagasse and their decomposition products increase the soils' ability to hold water and plant nutrients.

Figure 6 shows chlorotic cane growing on sandy soils at Wailuku. In the background, cane is growing luxuriantly on the same soils treated with organic matter. Poor root systems in untreated sandy soils at Kahuku are seen in Figure 7, while well developed root systems extending into the interline are seen in Figure 8, where trash and bagasse were applied.

IRRIGATION RESEARCH AIMS TO EVALUATE MAJOR FACTORS WHICH CONDITION ENTRY OF WATER INTO HAWAIIAN SOILS

A new furrow infiltration measuring technique has been developed for use in furrow irrigation systems. (Figure 9) The first studies using this apparatus have shown that three major conditions materially influence the furrow infiltration rate: first, dryness of the soil (Figure 10); second, roots and root action during successive wetting and drying periods as the cane increases in age; and third, tillage history. (Table III)

The data obtained from infiltration tests are expressed in terms of minimum furrow inflow rate values which can be used to specify the range of flows expected from flume outlets. These same data may also be used to divide irrigation water into two streams suitable for furrows.

Table III
Effect of Composition on Infiltration Rate (in./hr.)

Soil Family	N6	N2	N2	H2
Check Area	3.5	7.4	20.0	0.58
Compacted Area	1.0	1.3	4.6	0.12
Ratio	3.5	5.7	4.4	4.8

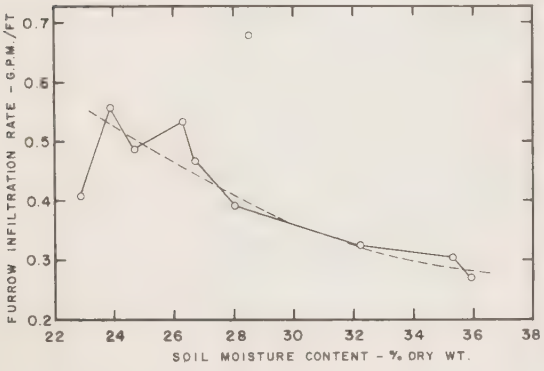
Figure 6. In the foreground, normal chlorotic cane growing on untreated sandy soils at Wailuku. In the background, cane growing luxuriantly on sandy soils that have been treated with organic materials.

Figure 7. Poorly-developed root system in the untreated sandy soils at Kahuku. The roots are confined in a small volume of soil directly beneath the stools.

Figure 8. Well-developed root system in sandy soils at Kahuku that have been treated with cane trash and bagasse. These roots, extending into the interline, support superior cane growth.

Figure 9. The HSPA barrel technique for studying infiltration of water in furrows.

Figure 10. The effect of soil moisture on furrow infiltration rate.



MODIFIED PARSHALL FLUMES INTRODUCED TO EVALUATE IRRIGATION SYSTEMS AND FIELD LAYOUTS

Furrow water distribution studies are being conducted on Hawaii, Maui, Oahu, and Kauai, using a newly-introduced modified Parshall flume. Figure 11 shows a typical flume installation with a calibrated scale which is used to indicate the rate of flow through the flume.

Preliminary flume tests have shown that the rate of entry of water into soil is nearly inversely proportionate to per cent slope. Soil infiltration capacity is obtained by metering water into various sections of furrows to give a basis for specifying the time that water should run in the furrow during irrigation to get a desired inch application. In furrows of fixed length and slope, the relation between the rate of flume discharge and water distribution can be obtained for a particular set of soil conditions and within a particular layout and irrigation system. Figure 12 shows typical test data. The area between successive curves is approximately the amount of water entering the soil within the section of furrow under test. A considerable weakness occurs in the center portion of the furrow. This is attributed to a main haul cane road through this portion of the furrow. A high inch application of water occurs at both the upper and lower sections of the furrow. By applying this flume technique to specific problems, more complete answers on how to obtain quality irrigation will be obtained and applied to furrow layouts and irrigation practice.

BOUYOUCOS BLOCK IRRIGATION CONTROL EXPANDING

Several thousand Bouyoucos blocks have been sent out for both experimental and control purposes. During the year, several of the plantations have expanded their control programs after exploring the possibilities of the instrument. Critical resistance readings are being established for specific soil types by checking elongation of the growing crop, and then scheduling irrigations two or three days before symptoms of distress appear. The block control program is functioning satisfactorily in the interim until more satisfactory instruments are perfected for scientific irrigation control.

Figure 11. Modified Parshall flume used in water distribution studies.

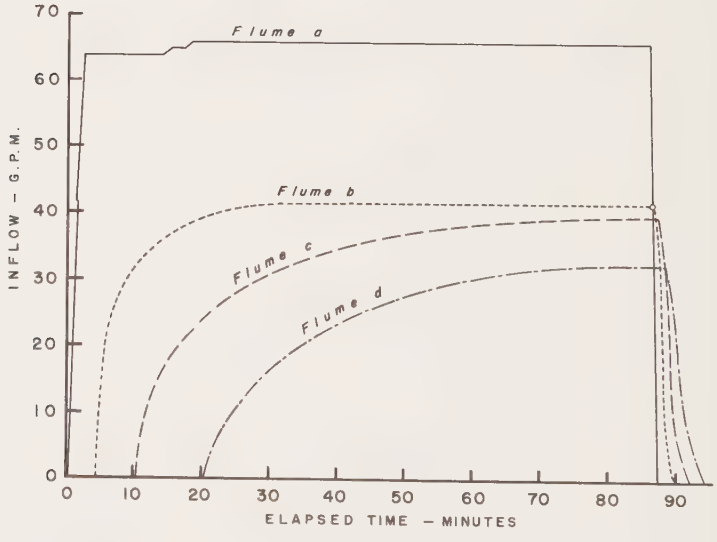


Figure 12. Soil infiltration capacity from water metered into sections of furrows. From these data, the time that water should run in order to give a desired inch irrigation is obtained.

Flume	Total Water Passing Each Flume. Gal.	Furrow Increment Feet	Water Applied Per 50' Gal.	Water Applied Per 50' Inches	Apparent Infiltration Rate In./hr.	Average Slope Per cent
a	5593	50	2251	13.2	10.1	−2.1
b	3342	50	687	4.0	3.1	−2.3
c	2655	50	803	4.7	3.8	−2.0
d	1852	50	1852	11.0	9.6	+0.6

Figure 13. Radioactive rubidium studies in water distribution.

RADIOACTIVE RUBIDIUM STUDIES IN WATER DISTRIBUTION CONTINUED

The use of tracer techniques with radioactive rubidium in studying water distribution was continued for the third year. (Figure 13) The statistical precision of soil sampling has been checked and found to be well within the range required for satisfactory field work. In 19 field tests, calculated water inflow measured by the rubidium technique was found to agree very closely to water measured by Parshall flumes. A correlation coefficient of 0.999 was found to exist between the two methods.

These cooperative tests between the departments of Agronomy and Physiology and Biochemistry are pointing out weaknesses in timing of water flow and volume of water used under the present layout and system of irrigation. Weaknesses in length and slope of line are also indicated. When fuller data are compiled, changes in design can be scheduled to obtain a better distribution of water.

MEASURING SOIL MOISTURE WITH GAMMA RAYS

Cobalt 60 and cesium 137 are being used as sources of gamma rays for measuring soil moisture in two experiments by the Department of Physiology and Biochemistry. Both are giving satisfactory results. There are obvious advantages in having absolute moisture values continuously available without disturbing the soil. The readings are taken at several depths across the main root system.

RELATION OF PHOTOSYNTHESIS TO SOIL DRYING STUDIED

A detailed study of the relation of photosynthesis to water supply is being made with potted plants. The soil moisture is being measured by the gamma ray method using cesium 137. The rate of uptake of carbon dioxide from the air is being followed continually on a recording infrared spectrophotometer. The tops of the plants are sealed into glass chambers as shown in Figure 14. Exact time relations between soil wilting coefficient, plant wilt and photosynthesis are being sought.

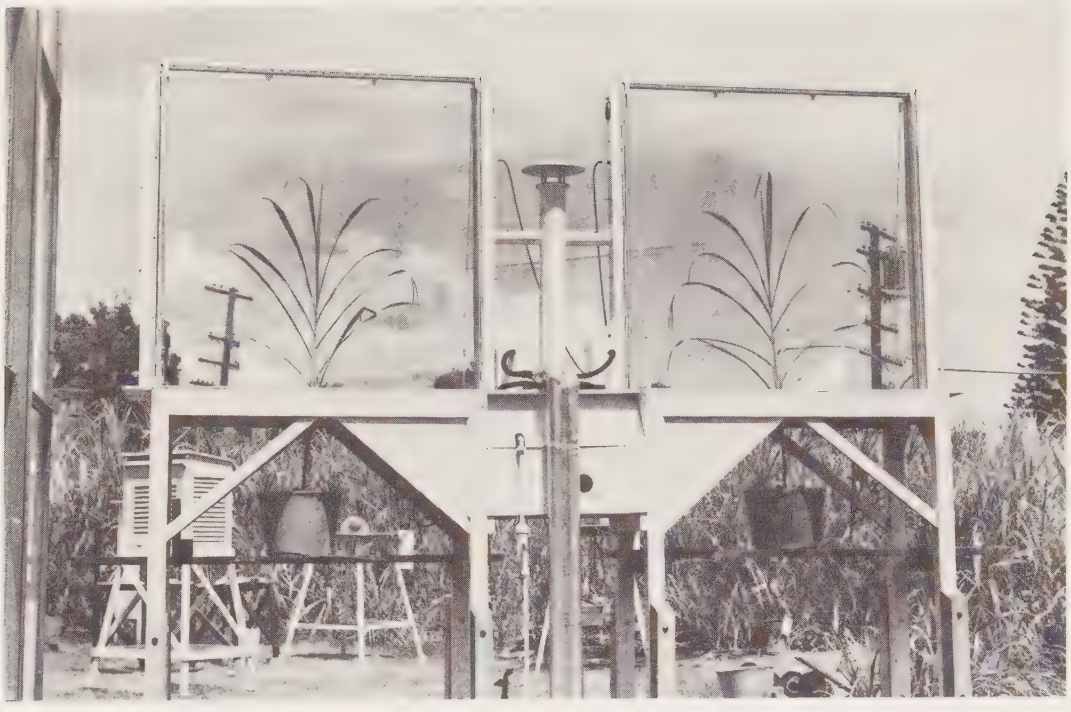


Figure 14. Photosynthesis by pairs of plants is followed continuously on a recording infrared spectrophotometer which receives the circulating air from the chambers. When water is withheld from one plant, it soon falls behind the watered control plant.

MOISTURE TENSION CHARACTERISTICS DETERMINED FOR PRINCIPAL SUGAR CANE SOILS

An expanded program of characterizing the moisture sorption properties of the principal soil types has given basic information now being used in irrigation research and in irrigation interval control on plantation fields. The soil types are found to vary in their ability to hold and release moisture.

TILLAGE STUDIES RESULT IN MODIFIED PRACTICES

Soil volume weight studies have revealed that subsoil densities of many of the red soils are extremely high. Root development is often restricted to plow depth. Deeper plowing of such soils, so that a few inches of the subsoil are incorporated with the surface soil, results in a deeper rooting habit. The subsoils are always low in organic matter and are often very deficient in phosphorus. Additions of mill trash or bagasse and phosphorus, whenever they are needed, convert the mixture of surface soils and subsoils into a more productive soil.

TILLAGE OPERATIONS AFFECT EROSION LOSSES

The use of subsoilers in easily erodible soils leaves more trash on the surface which helps to protect the soil from "splash" and "sheet" erosion.

Plantations in the Kau district are now using large duckfoot subsoilers with attached furrowers to prevent the formation of a furrowsole and to align the furrows in the shattered zone. (Figure 15) To prevent "channel" erosion, furrows are opened at right angles to the direction of surface runoff.

Figure 15. Seedbed preparation by duckfoot subsoilers with attached furrowers is shown with the furrows properly aligned in the shattered zone.

COMPACTION PROBLEMS SEVERE IN 1954

Harvesting operations during this year of abnormally high rainfall have resulted in larger areas of severely puddled and compacted soils. Studies on depth and degree of compaction, together with rooting habits of the ratoon cane, have been continued in evaluating the compactive effect of various pieces of harvesting equipment on different soils and under several soil moisture conditions. In the low humic latosols, restricted root growth develops at densities of around 70 pounds per cubic foot and above 95 pounds the soil is too dense for root penetration. (Figure 16)

Examples of the effects of compaction on root growth are seen in Figures 17 and 18, taken at HC & S. The root system of cane in normal growth shows an extensive development of primary and secondary roots to depths of at least two feet. In the compacted zone, less than 30 feet away, root growth was limited to a few inches in the surface soil. Even here the roots were fewer in number and deformed, particularly where they penetrated the more compact soil, and the absence of fibrous secondary roots indicates marked reduction in efficiency.

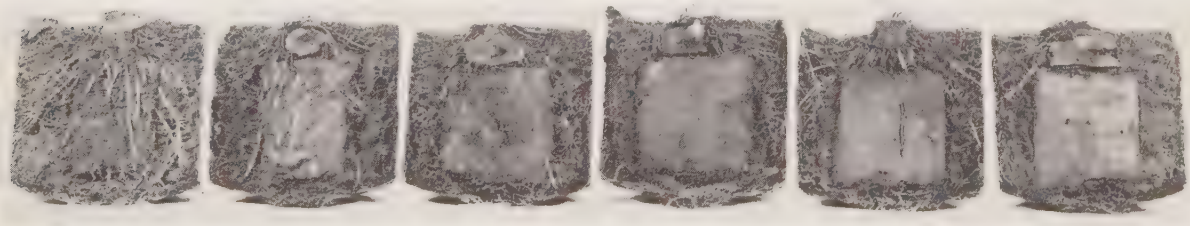


Figure 16. Root penetration studies in an HC & S soil, compacted to densities of different degrees, show clearly the restricted root development in densities above 70 pounds per cubic foot.

Figure 17. Here in a field at HC & S is normal root growth in a first ratoon crop of 38–2915 which is six months old.

Figure 18. Here in a compacted area of the same field, the root system is restricted and deformed, and is confined to a few inches near the surface.

COMPACTED SOILS REQUIRE SPECIAL TREATMENT

Inadequate seedbed preparation of badly compacted infield roadways leaves the soil so lumpy that germination and subsequent growth are impaired. A reduction in the size and percentage of lumps results in a greater volume of effective soil from which the roots can obtain nutrients and water. (Figures 19 and 20)

Studies have been conducted on depth of compaction and the amount or degree of compaction for various soils at different moisture contents. Field and laboratory studies are being made on relationships of ground pressure to soil moisture for various degrees of compaction. These investigations are resulting in modifications both of the equipment being used and of the timing of operations.

Figure 19. Proper reconditioning of a compacted infield road.

Figure 20. Inadequate seedbed preparation of a compacted infield road.

DISEASES

DOWNY MILDEW AND FIJI DISEASE TESTS IN FIJI GIVE INTERESTING RESULTS

Ten Hawaiian commercial sugar cane varieties now occupy 96.62 per cent of the total sugar cane acreage in the Territory. These varieties have been planted in tests to establish their reactions to downy mildew and Fiji disease, first in Samoa, prior to 1952, and since then at Lautoka, in Fiji, in cooperation with the Colonial Sugar Refining Co., Ltd., of Australia.

The reactions of these 10 varieties to the two diseases have been determined as shown below.

The reactions of many of the promising commercial and breeding canes to downy mildew and Fiji disease have also been determined.

A study of the varietal resistance tests in Fiji shows that many more varieties are resistant to downy mildew than to Fiji disease. If the same proves to be true in subsequent tests, then it may be concluded that downy mildew would be the lesser threat to Hawaii as the control of Fiji disease by resistant varieties would be more difficult.

During the year, members of the Pathology Department assisted Perry E. Robinson, pathologist, and other officers of the Colonial Sugar Refining Co. in installing new trials in Fiji and in recording the varietal reactions to disease in both old and new trials.

Variety	Per Cent of Total Acreage	Reaction to Downy Mildew	Reaction to Fiji Disease
37-1933	32.57	++	=+
44-3098	22.16	−	−
38-2915	16.23	=−	−−
32-8560	9.60	++	−
32-1063	7.26	=+	−−
39-3633	3.24	+	+
39-7028	2.93	++	=
38-4443	1.39	+	−−
40-1179	.68		−−
41-3340	.56	=	−−
Total	96.62		

Symbols: + or ++ Resistant or highly resistant
=+ Moderately resistant
= Average resistance
=− Moderately susceptible
− or −− Susceptible or highly susceptible

MOLOKAI QUARANTINE ADOPTS LONG HOT-WATER TREATMENT

Canes under quarantine at Mapulehu were periodically inspected for symptoms of diseases foreign to Hawaii. No such symptoms were found.

In cooperation with other members of the Quarantine Committee, 25 varieties were released from Mapulehu quarantine in March 1954. All cuttings released either came from cane which had been given the long hot-water treatment (LHWT–50° C. for 2 hours) or had themselves received this treatment. Twenty-five new varieties were received from Washington, D. C., on October 22, 1953, and were planted in the quarantine house where they will be grown for a period of one year before undergoing another year's quarantine under field conditions. Two of these varieties failed to become established.

LOCAL DISEASES RECEIVE EMPHASIS

Plantation inspections made during the year show that economic losses from disease have occurred in specific areas, but not generally throughout the Territory. The status of the diseases of greatest importance to the sugar industry, and laboratory and field investigations of them, are reviewed below.

Figure 21. The depressed growth on the right, in young 32–8560 ratoons at Makiki, has been caused by ratoon stunting disease. The plant cane was planted with diseased cuttings and showed a high incidence of the disease at harvest. The ratoons on the left are from cane planted with diseased-treated cuttings. RSD causes depressed cane growth, and is controlled by long hot-water treatment.

RATOON STUNTING DISEASE COMMANDS ATTENTION

Plantation surveys showed that symptoms of ratoon stunting disease (RSD) in the commercial canes have not increased within the past year. While RSD was found in several varieties, the disease has not become widespread in commercial plantings. With the control measures now in operation, it is hoped that serious losses from the disease can be avoided. Definite steps are being taken by the plantations to control it. (Figure 21)

The majority of plantations have installed block plantings of one or more of their leading varieties with seed given the LHWT. Such seed sources may be used for future variety testing and for spreading varieties without being concerned that RSD will be a factor in causing reduced yields. Planting material of 44–3098, 37–1933, 32–8560, and to a small extent H109, from the disease-free areas at Waipio Substation, has been furnished for establishing disease-free nurseries on plantations.

The results of experiments conducted in Hawaii on transmission and control of RSD are summarized:

1. RSD is controlled by the LHWT and by the hot air treatment (HAT–54° C. for 8 hours). The 52° C. for 90- and 120-minute treatments were very effective in controlling RSD, but caused too great a reduction in germination for practical use.

2. RSD is readily transmitted by contaminated cane knives and by cane juice from diseased plants.

3. No transmission of RSD occurred when contaminated knives were swabbed with 5 per cent lysol solution (Figure 22), 50 per cent alcohol, phenyl mercuric acetate (PMA) (1–100) or Bionol (1–100). Other chemicals tested gave only partial or limited control of RSD.

4. No symptoms of RSD developed on varieties inoculated with filtered disease-juice. Definite symptoms developed in canes inoculated with unfiltered disease-juice.

5. Symptoms of RSD failed to develop on 47–4991 when it was inoculated with disease-juice from the same variety which had been frozen for three months.

6. Plants developing from cuttings given the

Figure 22. Transmission of ratoon stunting disease by cane knives can be prevented by swabbing the knives with a 10 per cent lysol solution.

LHWT and dipped in disease-juice while the ends were still wet showed a much higher percentage of RSD (80.9 per cent) than when the cuttings were allowed to dry for two hours before inoculating them with disease-juice (30.6 per cent).

7. No evidence was obtained that different strains of RSD might occur when healthy cuttings of 32–8560, 37–1933, 38–2915, 44–3098, 47–4758, and 47–4991 were inoculated separately with disease-juice from 47–4991, 47–4758 and 48–3166. The symptoms in the six inoculated varieties were similar, but there appeared to be differences in varietal tolerance to the disease. 37–1933 produced more intense internal symptoms than the others; for this reason, it will be used to a greater extent in future transmission studies.

8. No transmission from diseased to healthy plants took place through the roots when two diseased and two healthy plants of 47–4991 were grown in a complete nutrient solution in each of six containers.

Recommendations for controlling RSD

1. Select healthy planting material.

2. Establish disease-free areas as seed sources of all commercial and promising varieties by subjecting seed to the LHWT prior to planting. Rogue all volunteer stools from previous crop to prevent transmission of RSD to healthy plants.

3. Sterilize cane knives by swabbing with a 10 per cent lysol solution. Use sterilized knives for cutting seed in disease-free areas and cane used in crop log samples.

As soon as information on varietal resistance becomes available, it is hoped that the use of resistant varieties will play a major part in the control of the disease.

LEAF SCALD MORE SERIOUS ON HAWAII IN 1954

Leaf scald was moderate to severe on 44–3098 in localized areas of the Kapoho and Kamaili sections of Olaa Sugar Company, Ltd. (Figure 23) In each case, the cane was approaching maturity,

Figure 23. Leaf scald disease affecting 44-3098 at Kamaili, Olaa. Note the dead and dying stalks and the side shoot development caused by the disease.

was growing in very rocky soil, and had been exposed to periods of drought. The disease was also causing some damage to 44–3098 in the Olaa section. A few cases of leaf scald were noted on 44–3098 at Hilo Sugar Plantation Company.

In cooperation with Olaa, the following experiments were designed and installed at Kapoho to study varietal resistance and the transmission and control of the disease:

1. Replicated plots were planted with cuttings of 26 of the commercial and most promising varieties, and were inoculated with the leaf scald organism to determine the reaction of each variety.

2. Disease-free seed of 44–3098 from the LHWT area at Waipio, inoculated and not inoculated with the leaf scald organism, was planted to determine how soon symptoms of the disease would develop subsequent to artificial and natural infection. Further information on the transmission of leaf scald under field conditions is also sought.

3. Diseased cuttings of 44–3098 were given the hot water treatment (HWT 50° C. for 30 minutes) and the long hot water treatment (LHWT 50° C. for two hours) and were planted with untreated diseased cuttings to determine the control effected by each treatment.

CHLOROTIC STREAK APPARENTLY NOT TRANSMITTED THROUGH ROOTS

Water culture studies were conducted at Makiki to determine if chlorotic streak is transmitted from diseased to healthy plants through the roots growing in complete nutrient solutions. Trojan, which is very susceptible to chlorotic streak, was used in these studies. Six replications, with two diseased and two healthy plants in each pot, were harvested at the end of 14 weeks. On June 7, 1954, one healthy

plant exhibited definite symptoms of chlorotic streak. No conclusions can be drawn from these results. In similar tests conducted a number of years ago, little or no transmission took place through the roots.

The few cases of chlorotic streak which developed in the ratoons of a replicated test at Kailua made it impossible to evaluate the reaction to the disease of the 19 commercial and breeding canes. The dry weather precluded a high incidence of the disease.

Chlorotic streak was still common in poorly-drained areas on Hawaii. However, it has been demonstrated that HWT controls the disease, and it is anticipated that it will be less severe now that the majority of those plantations where it is a problem are planting fields with seed given the HWT + PMA or hot PMA (HPMA) treatment.

LEAF FRECKLE ABSENT DURING DRY, WARM WINTER

Very little leaf freckle developed during the winter months of 1953–54 as the result of the unusually dry and warm weather which prevailed, thus making it impossible to draw any conclusions from the cooperative experiments on Hawaii and Kauai. In acid soils, growth response was noted with those treatments including high phosphate, mud press, lime and the DD mixture (soil fumigant).

The soil exchange tests, where 44–3098 was grown in good makai soil under mauka conditions, again demonstrated a direct correlation between a low degree of freckle and high soil fertility.

PYTHIUM ROOT ROT CONTROL

Seventeen new chemicals were tested for control of *Pythium* root rot of cane seedlings in the laboratory. Some of these will be tested against the organism in flats when seedlings are again available. There was very little infection of cane seedlings with *Pythium* during the 1954 season.

Fifteen actinomycetes isolated from the soil showed markedly antagonistic properties against the *Pythium* root rot organism on various media in the laboratory. However, these organisms, when tested in the soil, failed to prevent the development of the *Pythium* organism on cane seedlings.

The displacement of soil solutions with alcohol was carried out to determine if the actinomyces previously tested in flats produced antibiotics in soil. No antibiotic substances were found to have developed in the soils as tested by the paper disc method of assay.

Pure actidione, an antifungal antibiotic, seemed to have effectively inhibited the development of *Pythium* root rot of sugar cane seedlings at the rate of 50 ppm. Higher concentrations were definitely toxic to the seedlings. Indications are that the development of *Pythium* root rot may be retarded by frequent irrigations of the seedlings with a 25 ppm actidione solution.

RED ROT SHOWS UP ON KAUAI

Red rot disease (Figure 24) was causing serious damage at The Lihue Plantation Company, Ltd. to 38–2915 cane which was about 14 months of age. Heretofore, red rot has never been of major importance in Hawaii. In Australia and Louisiana it is of major significance. Cane varieties affected with red rot should be harvested as early as possible. Excess moisture, either from rains or irrigation, favors the disease. Infection takes place through mechanical injuries (rats, borers, cracking, etc.), through the old leaf scar and through the rudimentary root tips at the nodes. Red rot in other countries, when serious, accounts for a great deal of dead cane at harvest and for poor juices.

GROWTH FAILURE ON 47–4991 AT WAIPIO

The acute growth failure of 47–4991, when planted at Waipio Substation in September and October 1953, with cuttings which had received the LHWT, indicates that the poor growth was

Figure 24. Stalks of 38–2915, affected with red rot disease, show irregular reddish areas extending through one or more internodes. Scattered through the discolored areas are whitish spots with their long axes at right angles to the cane stalk.

caused by a factor or factors other than ratoon stunting disease. Similar results occurred in earlier plantings.

The time of year at which 47–4991 is planted at Waipio seems to have a marked influence on its growth. This problem is being investigated.

PINEAPPLE DISEASE UNDER GOOD CONTROL

Very few cases where pineapple disease was causing poor germination were observed or reported.

This is explained chiefly by the fact that this disease has been controlled mainly by treating seed with PMA prior to planting.

DROUGHT CAUSES STEM GALLS ON SOME VARIETIES

Stem galls developed freely on the internodes of 39–3633 and 44–3098 when they were first subjected to drought conditions and then given adequate moisture for growth.

Numerous galls developed on 51–9037 when it was subjected to high soil moisture conditions only. No galls developed on 37–1933 when it was exposed either to drought or to high soil moisture conditions.

These results are in agreement with earlier reports of gall development on canes subjected to drought under controlled irrigations.

POKKAH BOENG NOT SERIOUS

A light outbreak of pokkah boeng disease occurring on Hawaii affected some varieties more than others. The affected plants soon recovered and losses from the disease were not great. The spores

of the causal organism are always present, and during warm, moist periods the fungus will develop rapidly and cause injury to susceptible varieties. Pokkah boeng in Hawaii has been of little importance. However, it is one of Java's major diseases since their wet and hot seasons coincide.

PMA INCREASES GERMINATION DURING DRY PERIODS

The effects on the per cent germination of 37–1933 at Waipio from seed treatments with PMA and HPMA over no treatment, immediately following irrigation and at two and four weeks after planting, were striking, and are tabulated below.

These results are in agreement with previous tests wherein delayed irrigation greatly reduced germination. They also show the benefits derived from planting cuttings which are protected by PMA treatment against rot-producing organisms of the seed piece whenever soil moisture is likely to be a limiting factor after planting.

Irrigation	Per cent Germination		
	No Treatment	PMA	HPMA
Immediately	43.0	46.7	76.3
After 2 weeks	35.0	51.9	61.9
After 4 weeks	17.0	51.9	58.0

FACTORY

SUGAR LOSSES IN HARVESTING AND CANE CLEANING INVESTIGATED

An investigation of sugar loss in harvesting and cane cleaning was completed at four plantations, two irrigated and two non-irrigated. Average sugar losses are shown in the table below.

Since the methods at the four plantations studied include the operations typical of the Hawaiian industry at this time, it may be concluded that total sugar loss due to cane damage ranges from 2.7 to 5.7 per cent. These losses do not include losses of cane left in the field, dropped along the road, or removed by the cane cleaner with rocks and trash.

Rake-harvesting at HC & S, under very dry conditions, and grab-harvesting at Waialua Agricultural Company, Ltd., under somewhat less favorable conditions, showed almost the same field loss.

Hand slash-cut harvesting at Hilo Sugar showed a much higher loss than that shown by mechanical harvesting on the irrigated plantations. Following hand-cutting, however, several mechanical operations are used. These include rake-windrowing, grab-loading into an infield transport, dumping at the roadside, and grab-loading into a truck. Also, the interval of 24 to 48 hours between harvesting and loading gave time for the cane to deteriorate as well as for heavy rains to wash pol from damaged stalks. Thus, losses which otherwise would show up in the cleaner, appeared in the field.

Under similar harvesting conditions at Pepeekeo Sugar Plantation Company, the sugar loss was significantly less. Factors contributing to this were lower pol to fiber ratio and apparently a more damage-resistant variety: 44–3098 at Pepeekeo compared with 39–3633 at Hilo Sugar.

Losses with rake-harvesting at Pepeekeo were 50 per cent greater than with hand-cutting.

Cane cleaner losses at the non-irrigated plantation factories were less than at the irrigated ones. This is due to some washing by rains in the field and to simpler design of the cleaners which handle non-irrigated cane.

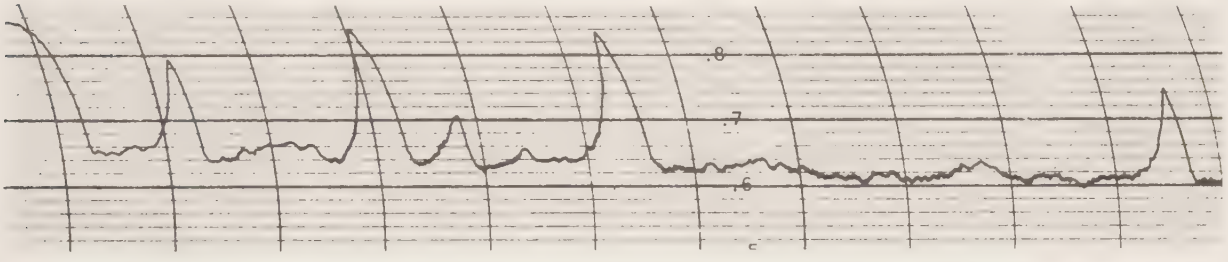
Plantation	Harvesting Method	Average Per Cent Sugar Loss (Pol Basis)		
		Field	Cleaner	Total
HC & S	Rake	2.9	2.8	5.7
Waialua	Grab	2.8	2.8	5.6
Hilo	Slash-cut	4.1	1.6	5.7
Pepeekeo	Slash-cut	2.3	0.4	2.7
Pepeekeo	Rake	..	..	4.1

GAMMA RAY WEIGHING DEVICE OPERATED AT EWA

An experimental gamma ray absorption device to weigh both raw sugar and bagasse has been operated at Ewa Plantation Company in cooperation with the Physiology and Biochemistry Department. The unit, directed across a free fall of bagasse at the end of the milling train, has demonstrated the soundness of the principle for practical application. Figures 25 and 26 show the bagasse spillway and the record of a six-hour run on July 29, 1954. Commercial measuring and recording equipment has been ordered so that measurements can be made on a production basis.

Figure 25. In the gamma ray scale, installed at the bagasse spillway of Ewa mill, cesium 137 was substituted for cobalt 60 as the source of radiation. Calculations indicate that errors of measurement can be kept within the desired range.

Figure 26. Record of a run on the bagasse spillway from 8 a.m. to 2 p.m. on July 29, 1954. Rate-meter half-time, 100 seconds. 3000 counts per minute. Momentary changes in the load of bagasse are shown by the fluctuations of the chart line.



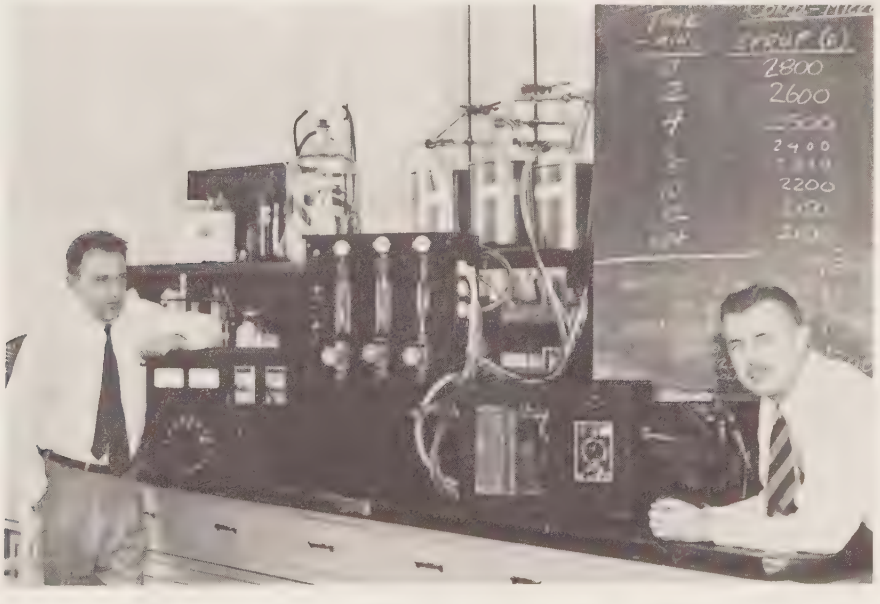


Figure 27. Ionics, Incorporated demineralizer set up in the Sugar Technology laboratory.

MEMBRANE PROCESS PROMISING FOR PARTIAL DEMINERALIZATION OF SUGAR JUICES

Laboratory tests on Hawaiian juice and syrups were completed at Cambridge, Mass., by Ionics, Inc. This work, sponsored jointly by the HSPA and Godchaux Sugars, Inc., indicates that the process may have economic potential in the partial removal of salts from sugar liquors. This makes it of particular interest in the treatment of Maui liquors for solving the potassium chloride problem.

A demonstration unit was operated on syrup and B molasses for several hours in the Station laboratory to familiarize the staff with the principles involved. (Figure 27)

An economic survey will be made to determine if pilot plant operation in Hawaii is warranted.

FUNDAMENTAL PRINCIPLES OF SEPARATION OF INSOLUBLES FROM JUICES STUDIED

During the year, a study was started of the fundamental principles involved in the separation of insoluble materials from mixed juice, clarified juice and Oliver filtrate. Filtration, sedimentation and flotation were investigated.

Cyclones

A miniature liquid cyclone, which removes material of small particle size, but limited range, was found to be of little value in the treatment of mixed juice and Oliver filtrate. It was concluded, however, that large cyclones might be useful in removing large-size solids from juice and filtrate prior to other clarification treatments.

Flotation

Froth flotation was found to have good possibilities in mixed juice clarification. (Figure 28) Effectiveness of flotation depends much more upon the characteristics of the juice than upon the nature of the treatment used. Factors responsible for variability in juices will be studied.

Pressure Filtration

A "compression-permeability" testing unit was built for determining the filtration characteristics of filter cakes under various conditions of operation.

A laboratory pressure filter has been designed with which it will be possible to determine actual filtration curves which can be used to check calculated curves obtained from testing unit data.

Figure 28. Froth flotation clarification of mixed juice.

SODA ASH REDUCES VOLUME OF SETTLINGS

Investigation of the effect of soda ash in clarification has shown that this material reduces the volume of settlings. An adverse effect on the turbidity, color, and ash of the clarified juice is usually found, however. Soda ash should be helpful when high volume of settlings is reducing capacity.

POTASSIUM CHLORIDE CRYSTALLIZATION IN MAUI LOW-GRADE MASSECUITES

Cooperative work on a study of methods for preventing crystallization of potassium chloride in low-grade massecuites was continued with HC & S and was extended to Pioneer Mill Company, Ltd., where the problem became serious also.

Control methods, established by the staff at

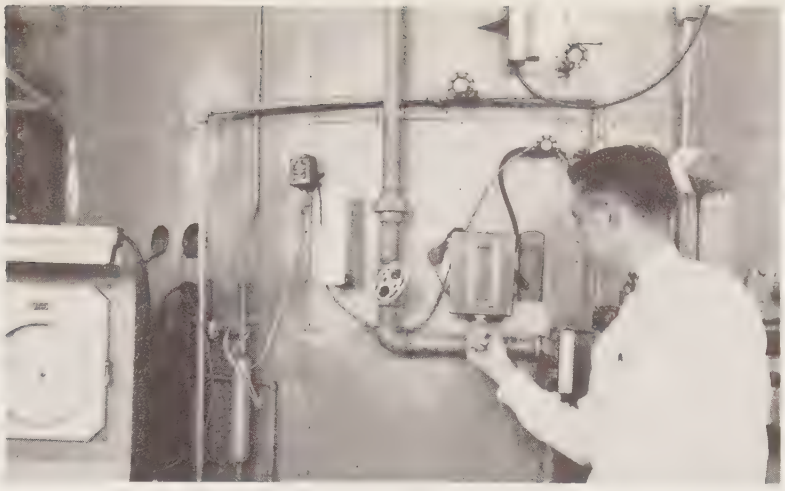


Figure 29. Vacuum pan refractometer on low-grade pan at Ewa.

HC & S and involving the use of molasses from the Hilo area, appear to have been helpful in this year's operations.

At present, the most promising solution is partial demineralization by the Ionics' membrane process.

PAN REFRACTOMETER EFFECTIVE AT EWA

A Bellingham and Stanley vacuum pan refractometer, imported from England by the Station, has been in operation on a low-grade pan at Ewa for several weeks. (Figure 29)

The results have demonstrated that the instrument is a valuable aid in the control of low-grade sugar boiling. Extensive use of the instrument is anticipated.

pH IS IMPORTANT FACTOR IN SCALE FORMATION

Tests on the laboratory-scale apparatus with several scale-inhibiting substances, including "Versene" and "Kelgum", have demonstrated the importance of pH in scale formation. Versene inhibits scale formation in all cases if the pH is adjusted to 7.0 to 7.5. Kelgum appears to behave in a similar way. If the pH is lower than 7.0, however, these substances are often entirely ineffective. The value of soda ash alone in decreasing scale is being studied.

INSECTS

The long-established cane pests continue under excellent biological control. A new army worm has appeared on Oahu, and its possibilities as a pest of sugar cane are being studied.

LIGHT TRAP CATCHES NEW ARMYWORM MOTH

In December 1953, a moth new to Hawaii was caught in a light trap for the first time at Ewa. It is *Spodoptera mauritia* (Boisduval), which occurs from Africa eastward into the Pacific. (Figure 30) The caterpillars are especially destructive to rice plants in India and the Philippines, and also attack sugar cane. The moth probably got here by airplane from Fiji or Guam, where it is common. Recently (September) lawns at Wailupe and Kailua, Oahu, were damaged by this armyworm. It seems probable that the parasites already present on other kinds of armyworms will effectively attack this species also. *Spodoptera* is being watched to determine its importance as a cane field pest.

ARMYWORMS MORE ACTIVE IN 1954

The most extensive armyworm outbreaks in several years occurred on Hawaii and Maui during the first half of 1954. Parasites were effective, and no destructive second generation of caterpillars developed in any cane area. An important reason for this is believed to be the clean condition of most cane fields, the result of excellent weed control. Grass-free cane fields almost always become infested by migrations of older caterpillars from nearby grassy areas, because, with occasional exceptions, the newly-hatched caterpillars can feed and survive only on tender grasses. Through the cooperation of the Board of Agriculture and Forestry, small colonies of a Mexican beetle which preys on armyworms were taken from a region into which the beetle was introduced in 1923, and released on two ranches which had suffered armyworm damage earlier this year.

BENEFICIAL INSECTS SENT TO OTHER COUNTRIES

Requests for shipments of beneficial insects to foreign countries were received during the year. The following shipments were made:

To Jamaica, *Cyrtorhinus mundulus* (a bug which feeds on eggs of various leafhoppers), for trial against the West Indian sugar cane leafhopper.

To Bolivia, *Microceromasia sphenophori* (the fly parasite of the New Guinea sugar cane beetle borer), for trial against a related borer in cane. A similar shipment to Bolivia was made in 1953.

ARGENTINE ANT HAS NOT SPREAD

The status of the Argentine ant remains unchanged. There has been no great extension of the areas which this immigrant ant occupies and no serious interference with the biological control of mealybugs on sugar cane in infested fields. It occurs on Hawaii, Maui and Oahu.

Figure 30. The adult *Spodoptera mauritia* moth, a new armyworm now established on Oahu, has a wingspread of about 1.5 inches. Records of this species in Hawaii prior to 1938 were based on incorrect identification of another armyworm. The full-grown caterpillar of the moth is about 1.25 inches long.

ROOT-PITTING INSECTS IN THE SOIL

The majority of the many minute insects which normally live in the average acre-foot of Hawaiian plantation soils, feed on cane roots; most of the injury is in the form of tiny pits. When pits occur along the length of the root, the damage is usually unimportant. Pitting of the growing point, however, is more serious; root elongation stops, and one or more lateral replacement roots are produced. If growth is slowed by unfavorably low temperatures, the proportion of tip injury increases. In extreme cases, all the roots may branch and rebranch until an abnormal, stubby root system results.

Chlorinated hydrocarbon insecticides, which remain effective in the soil for months and even years, afford a means of deleting the root-feeding soil insects from the "growth failure" complex, and so, perhaps, of clarifying other factors involved in the problem. Such insecticides were used in the yield decline experiments, and are being tested in other areas also.

MECHANIZATION

There has been some doubt in the industry as to whether the ultimate mechanical harvesting system would consist of single-operation machines or of machines combining certain operations, such as cutting and pickup. The policy has been to consider both types, so that the final development could be based to a convincing degree on results and observations.

The 1953 report of the Department of Agricultural Engineering, classified each project in the program as short, medium, or long range. This referred partly to the anticipated engineering and development time required for a machine or system to be brought to the point where its potential could be studied. Results to date indicate that the permanency of a machine or a system falls into a similar classification. A good quickie usually offers improvement but not an answer. Everything indicates that the industry will not be satisfied with anything less than machines and a system which will deliver clean, undamaged sugar cane to the mill with negligible damage to the field, and will do so under all kinds of weather conditions.

There has been an inclination to correct an effect rather than to get at the root of the trouble. An example of this is in the ratooning of irrigated cane. Most of the ratooning problems relate directly to the harvesting machinery and system used. A correct harvest system would leave furrows sufficiently intact so that ratooning would be a minor problem. Therefore, the program is being aimed more and more toward getting at the causes.

CUTTER-WINDROWER-TRANSPORT PERFORMS WELL IN UNIRRIGATED CANE

The cutter-windrower-transport for unirrigated cane was designed to combine the developments of the side-mounted cutter-windrower and the cane buggy prime mover. The completed machine weighed 23.75 tons. Based on the over-all area of the track shoes on the ground, the calculated ground pressure is 6.4 pounds per square inch. This gives it a much greater potential in wet conditions than the side-mounted machine with the 18:00 × 24 outboard wheel. (Figure 31) The machine is powered by a single 175 hp engine. Mechanical drives were used throughout, with an agricultural clatter-type overload clutch in the drive to each conveyor and subassembly. The initial operation was started at Hawaiian Agricultural Company on October 21, 1953.

Preliminary field operation was satisfactory, the location of the operator proved to be the most successful to date, and the initial mechanical failures were few and minor. The machine functioned as it was meant to do, but a few changes were made during the initial operation.

The flexible mountings of the ground knives were removed in order to improve the pickup. Additional slats were added to the elevating conveyor. The diameter of the side-trimming knife was increased from 32 to 40 inches. The air controls were a great improvement on hydraulic controls. The single-duty long-tooth conveyor-chain sprockets were a substantial improvement. The use of 3-inch pitch conveyor chain instead of 2.5-inch pitch seemed good. This machine was more convenient to load and transport than the side-mounted type.

An attachment was tried at Hawaiian Ag for topping the cane in the adjacent row. The tops which dropped on the prime mover track were carried over and left on the ground. The attachment

Figure 31. The cutter-transport is shown operating in wet, unburned cane.

should function satisfactorily after more development, and should make it possible to leave up to 50 per cent of the tops on the field when the cane is of uniform height.

After operation at Hawaiian Ag and Olaa in 1953, several major changes were made:

1. The cross-conveyor was shortened 28.5 inches on the closed end and lengthened 42 inches on the discharge end. The width of the cross-conveyor was decreased 11 inches. Extension of the discharge end left more room between the uncut cane and the ends of the windrows.

2. The upper end of the elevating conveyor was extended 16 inches to reduce back-feeding and to increase the load in the cross-conveyor.

3. The industrial-type master clutch in the prime mover, which was wearing out rapidly, was replaced by an oil-immersed clutch.

4. The chain drive from the engine, which drives the elevating conveyor assembly, was enclosed in an oil-tight housing.

1954 operation started on February 12 at Hakalau Plantation Company, and since then the machine has been operated at seven plantations. Under most conditions, the results have ranged from satisfactory to outstanding. The production has ranged from .42 to .98 acres per hour based on actual operating time, and has depended on field conditions and on the organization of layout and operations. Production in tons per hour is normally highest where the yield per acre is high. When the broom-up men helped to clean up the machine during stops for service or repair, the production time of the machine tended to increase. Maximum cut on wet-condition side slopes ranged from 14 to 27 per cent. When cutting up-slope with the direction of travel under wet conditions, the maximum cut recorded was 22 per cent. Under dry conditions, it has been possible to cut up 40 per cent slopes, and to cut across 30 per cent slopes. Maximum slope operation is sometimes reduced by a combination of side and travel-direction slopes.

The maximum slopes down which the machine cut and picked up satisfactorily have ranged from 5 to 20 per cent. Down-slope cutting with the present pickup is at the mercy of the recumbency pattern of the cane, but a project on pickup promises to change this situation.

This machine was equipped with two ground knives which cut five feet of the conveyor width, which was six feet. In fields where the culture was very flat, cutting across the line was satisfactory. In several fields, direction of cutting was based

Figure 32. The new cutter-windrower, shown operating at Lihue, has a 100 hp auxiliary engine which enables it to cut closer to the ground as a means of reducing liliko.

on the lay of the cane and the terrain, rather than on the direction of the lines.

Normally, the best production was attained by operating the machine as a cut-windrow unit. However, there were conditions under which it was advantageous to transport the four-ton gross load which could be accumulated on the cross-conveyor. At Olaa, it was possible to cut 325 feet in from the road and to deposit the cane in a windrow along the road. At several other places, it was possible to repeat this system when it was too wet for the transport to go into the field.

A new set of drawings is being made for this machine, and Kaiwiki Sugar Company Ltd. and Laupahoehoe Sugar Company are each having one machine manufactured. Design improvements are taking care of weaknesses which developed in the experimental machine. The major changes are:

1. One ground knife with two pickup tines will be used instead of two ground knives only.
2. The elevating conveyor lift cylinder will work against springs, instead of using a hydraulic accumulator.
3. The general arrangement of the drives in and to the elevating conveyor will be based on that of the cutter-windrower machines.
4. The gauge of the prime mover will be increased from 8 to 9 feet.
5. Three-inch pitch conveyor chain will be used throughout.
6. Accessibility to the prime mover will be increased.

SIDE-MOUNTED CUTTER-WINDROWERS IN PLANTATION OPERATIONS

A wet harvesting season has emphasized the value of cutter maintenance and the need for continued development. Weaknesses in maintenance and design frequently limit production under conditions of wetness and poor burns.

The cut-pickup-elevating conveyor assembly has been redesigned in cooperation with the plantations using this type of machine. (Figure 32) Two new assemblies are in operation at Lihue. A major consideration in the redesign was to standardize more of the parts and subassemblies. Some standardization has been accomplished; however, it was found that the need for further development limits the standardization possible. A new experimental

Figure 33. The experimental pickup tine assemblies, mounted on the direct-mounted cutter for unirrigated cane. Each tine assembly is driven and adjusted independently in order to explore the effect of changes in rake angle of the tines and in location, tilt, and angle of each assembly with the direction of travel.

Figure 34. Parts of the separate assemblies were combined and new parts were added to make up the experimental reel assembly, which is driven from one side and is mounted on the direct-mounted cutter. The location of the reel assembly in relation to the pickup roll, and the rake angle of the tines are both adjustable.

cut-pickup-elevating conveyor assembly has been designed and is being constructed. One of the objectives is to determine the value of making more power available to the ground knife for closer cutting in irrigated cane as a means of reducing liliko without loss of production.

No principle for the mechanical cutting of recumbent cane has been proposed or tried so far that seems as good as that of cutting the cane off at the ground, cutting it loose from the adjacent cane, and picking up the row of cane as a blanket and as a continuous operation. The adequate exploitation of this principle calls for more intensive cooperation with plantations using the equipment.

POSITIVE PICKUP FOR CANE CUTTERS PROMISING

The present ground knife, pickup tines, and pickup roll assembly of unirrigated cane cutters frequently gives poor results in cutting down slopes and in cutting with the recumbency of cane when there is a definite pattern. With recumbency, the greatest problem is to avoid sliding over individual stalks which lie flat on the ground with the direction of travel.

A fully adjustable overhead tine assembly was selected as a starting point to develop a more positive pickup. It was designed to fit onto the direct-mounted cutter for unirrigated cane, and when completed, it consisted of two tine assemblies of four tines each located over and slightly ahead of the ground knives. (Figure 33) Each assembly was fully adjustable to the pickup or rake angle of the tines, and to the location, tilt, and angle with the direction of travel. By having each tine assembly at an angle to the direction of travel, the cross-raking of the tines might lift the stalks in line with the direction of travel, as well as the tangled mass of cane.

The experimental operation did not show practical improvement in the pickup of stalks lying flat on the ground with the direction of travel. With the tine assemblies set to accomplish this type of pickup, some stools were removed unless the machine was steered with precision. However, the general pickup was substantially improved, particularly when cutting down slopes.

Figure 35. The irrigated cane "cutter-only" in operation.

These separate assemblies were then converted to a single reel-type assembly. (Figure 34)

The experimental operation of the reel has been satisfactory. A continuous pickup has been accomplished while cutting down slopes up to 30 per cent. One interesting aspect of this work is the indication that with a steady flow of cane onto the elevating conveyor, the slope of the conveyor can be much steeper without adding an overhead conveyor.

IRRIGATED CUTTER-ONLY DID NOT PROVE ADVANTAGEOUS

The self-clearing irrigated cutter-only was conceived as a relatively quick means of improving harvesting without making a complete change of system and equipment. It was realized that this additional machine in the harvest field would have to pay its way by improving the quality of cane delivered to the mill, by reduction of field damage, and by reduced costs of other machinery.

This project was continued in 1954 to explore more conclusively the potential of a cut-only operation and to make it possible to rebuild the machine into a better production unit.

The project machine was operated on Oahu and Maui, starting February 3. It completed its work as an experimental and development operation on July 9, having cut a total of approximately 90 acres. (Figure 35)

While the machine was operating, it cut approximately one acre per hour. Allowing for field delays and minor repairs, a cut of four to five acres per eight-hour shift could be expected. Changes made to the machine substantially improved its operation, particularly while crossing level ditches and operating on side slopes. This machine repeatedly demonstrated that a good job of cutting irrigated cane could be done, regardless of the lay of the cane, if adequate power were delivered to the ground knife so that it could cut close to the ground.

The last phase of operation was part of a sugar loss study comparing the cut-only and accumulation by push-rake operation with standard push-raking. There was no significant difference in the amounts of sugar lost.

Based on the conclusion that a cut-only machine in irrigated cane could not be made to pay off in better over-all results, the project was discontinued on a full-time basis on July 15.

Figure 36. The portable cane cleaner is shown loading cane cars with cleaned cane. Separated leaf trash is in the foreground, having dropped on the ground under the cleaner as it was shifted from car to car.

The value of the negative results should not be overlooked since such information contributes greatly to the development of new projects. The weaknesses serve as guideposts to indicate what must be avoided on future projects which will attempt to solve the harvesting problem.

PORTABLE CANE DRY CLEANER GIVEN FURTHER TESTING

The portable cane dry cleaner was initiated to explore more conclusively the potential and maximum efficiency possible with a field cleaner, in the hope that field cleaning would be an economical way to leave most of the leaf trash and extraneous material in the field. (Figure 36)

The first field cleaner used the already developed principle of cutting the cane into shorter lengths so as to cut the leaf trash loose from stalks, and then of separating them by means of notched (peg) tooth drum and blast of air. Essential conditions were to loosen most of the leaf trash from the stalks and then to feed a thin blanket of cane over the drum. For adequate capacity, the thin blanket must be fairly continuous.

In the design of the new machine, a carding elevator-conveyor was introduced to eliminate the carding drum at the end of the feed conveyor. This reduced the height of the feed conveyor from the ground by approximately six feet and introduced the possibility of lessening cane damage.

During 1954, in addition to minor changes made in the field, the project machine has been in the shop, between field operations, four times in an all-out attempt to determine the best performance which could be expected with this 9-foot wide machine. The major changes were:

1. The length of the feed table was increased six feet.

2. The rigid retarding or leveling fingers above the carding elevator-conveyor were replaced by a kickback-type of drum at the lower end of the conveyor. This drum was later placed near the top end of the conveyor.

3. The divider roll at the top edge of the division between the separated leaf trash and the cleaned cane was shifted several times.

4. The grasshopper-type knives were removed

from the carding elevator-conveyor. Four sickle-type knives were installed at the discharge end of the feed conveyor. The number of knives was later changed to three evenly-spaced knives. These knives cut a maximum depth of three feet.

5. A powered feed roll was installed ahead of the knives to roll on the cane in the feed conveyor and to aid the deck chains in feeding the cane through the sickle knives.

6. The rpm of the pegtooth drum was increased.

All the problems observed in operating the machine have been or can be considerably corrected with the exception of the problem of delivering a uniform, thin blanket of cane at the pegtooth-drum-blower assembly. This problem has persisted with use of the carding elevator-conveyor as the carding assembly. By doing the cutting ahead of the carding, instead of on the conveyor, the capacity and efficiency have been somewhat improved.

How a separate machine such as this could be fitted into a harvest system was also studied. The operation of this machine did not fit in easily with the cutter-windrower operation. The windrows normally laid down are too large for the cleaner to handle if the cane has received either a poor burn or none. As the separated leaf trash accumulates under the cleaner, it must be moved. With a heavy windrow of cane, the cleaner has to be moved faster than the windrow can be fed into it. From the point of view of the dry cleaner operation, a pickup-cleaner which picked up a light windrow of not more than four lines of cane appears to be the best possibility.

The problem of the disposal of the windrows of separated leaf trash became apparent. As improvised methods were not satisfactory, equipment must be devised which would spread the trash thinly and evenly.

One point that was established was the necessity of using cutter-cut cane for a dry cleaner operation. Next best was grab-harvested cane. Most push-raked cane, even with very favorable field conditions, had too much extraneous material mixed with it.

HYDRAULIC GRAB PRESENTS DIFFICULTIES

A cane grab, hydraulically closed, has three potential advantages over the standard wire rope grab: it is lighter, its operating cost is lower, and it is easier to operate. The wire rope grab has the advantage of a great deal of development.

Some background was acquired during 1953 with Bucyrus-Erie Hydrocrane equipment in use on the Waipio crane. The only modification was to increase the capacity of the grab. This equipment is normally used to load hand-cut experiment cane.

The new hydraulic grab, which weighed 1130 pounds and had an open span of 11.5 feet, was installed on a loader at Kohala Sugar Company. (Figure 37) The preliminary operation showed that more grab-closing pressure was required than had been anticipated. The setting of the relief valve was increased to 5000 psi. With the engine at operating speed, the pressure in the system could build up to 6000 psi. The high pressure quickly developed trouble with the hydraulic system. The problem which was most difficult to cope with was the

Figure 37. Experimental hydraulic grab which has an 11.5-foot spread.

Figure 38. The lightweight flume pickup unit has a cane lifting-dividing assembly on the front.

Figure 39. As the pickup unit moves slowly along, the flume is picked up and stacked on the machine.

failure of the leather cups on the hydraulic cylinder plungers. A substantial improvement was possible by the use of chevron packing.

The cross-ties between and near the tips of the tines were changed so as to offer minimum interference to closing. One structural failure in the grab occurred near the pivot point of one tine assembly. A check showed that failure was due to a high concentration of stress.

A basic point emphasized by the operation of the hydraulic grab is that a wire-rope grab needs less closing pressure, because when the resistance of the cane equals the closing pressure of the grab, the closing line automatically lifts the grab slightly and the closing normally continues. With the hydraulic grab, this slight lifting has to be accomplished with the lift line, or substantially more closing pressure must be provided. It has been estimated that the grab-closing pressure should be increased 2 to 2.5 times before the possibilities of a hydraulic grab can be adequately explored. This would require a redesigned grab and a new set of hydraulic equipment.

The following data should be considered as preliminary only. The comparison would be more reliable if changes to the machine controls and to the equipment could be made and if operators who had equal experience with both types of grab were available.

The following data were obtained from preliminary operation of the hydraulic grab at Kohala on September 3:

	Hydraulic Grab	Waialua-Type Grab
Average Grab Load (Lbs.)	4,019	5,150
Average Loading Time (Kohala truck and trailer) (Minutes)	14.5	7.5
Tons/Minute	1.76	4.55
Average No. of Grabs per Truck-Trailer Load	12.7	11.5
Average (Truck-Trailer) Load (Lbs.)	50,919	59,150

LIGHTWEIGHT-FLUME PICKUP MACHINE DEVELOPED

Aimed at filling the need for a pickup machine to remove lightweight flume ahead of burning and harvest, a machine has been developed which moves along astride of a flume, and has an assembly on the front which clears the cane off the flume and pushes it to both sides. The prime mover

travels over the pushed cane. Flumes and accessories are loaded in appropriate racks and boxes. (Figure 38)

The lightness of the prime mover, a 22 drawbar hp track-type tractor, made possible a relatively light and inexpensive machine. The track assemblies were increased in length by two rollers, spread out to 72-inch gauge, and the tractor was raised to give 30-inch clearance. The dividing assembly is V-shaped, with a scroll along each bottom edge. The flights and direction of turn are arranged to help part the cane. A lug-linked chain is on the point and ridge, with a rotating knife on the top shaft which cuts the cane which is lifted that high. This mechanism is driven by the standard power take-off. Above each track there is a flume rack wide enough to accommodate 48-inch flume. There is a box on the rear with a dump bottom for the accessories. There is a two-to-one reduction in the chain drive to the tracks so that the travel speeds are reduced to half standard. Low speed is .4 mph. The weight of the machine is 9880 pounds.

Preliminary results have indicated that such a machine is a solution to the problem. With good operation, it was possible to clean most of the cane off the flume, with two men picking up and loading as the machine passed. (Figure 39) One hundred and twenty Olokele-type flume sections and accessories can be loaded conveniently. The operator can normally follow the flume by sighting down behind the dividing assembly. The cane did not close in behind the machine, which is important not only for the pickup work but as a way out with the load, if necessary. Because of the lightness of the machine and of its load of leaf trash, the cane damage appeared to be low. The machine had adequate power because of the speed reduction.

Two operational problems became apparent. First, the rate at which flume was picked up was substantially slower than the push-rake operation. Rate of pickup can be increased. Second, it was a warm job with direct sunshine and with most of the breeze cut off overhead by the cane growing on three sides.

MECHANIZED HAND-CUTTING NOT PRACTICAL

A hand tool for cutting cane was fabricated by a manufacturer of compressed-air pruning equipment. The tool weighed 7.5 pounds and was carried and operated by one hand, leaving the other hand free to pull cane.

With limited operation, this powered hand tool was unable to offer any advantages over a cane knife, and to exploit its possibilities completely would require considerably more development. However, the limited work which has been done has indicated that it may be difficult to improve on the cane knife as an economic hand tool.

RESEARCH ON IRRIGATION FLUMES AND OUTLETS INITIATED

As a starting point toward determining what irrigation equipment is best suited for specified conditions, and whether or not further development is necessary or desirable, the industry has suggested that equipment now in use, particularly outlets, be critically compared.

An installation for studying flumes and outlets under controlled conditions was erected at Oahu Sugar Company, Ltd. over a supply ditch with a high degree of fall. Water is taken out of the supply ditch and carried out on a 2.5 per cent slope through a Parshall flume in a 48-inch metal flume. The flume test section is 86 feet long and the slope can be varied from 0 to 14 per cent. The outlet being tested is located 21 feet from the discharge end, and equipment is provided for measuring the discharge which spills back into the ditch. The test installation was designed for an 8 mgd maximum. (Figures 40 and 41)

The principal objective has been to develop a body of data and information to serve as a basis for recommending irrigation flume and outlets for use under different conditions of soil and terrain. A study of the principal types of outlets now in use

Figure 40. This installation tests irrigation flumes and outlets, and is located over a supply ditch at Oahu Sugar.

Figure 41. Close-up of outlet discharge collecting box, with downspout and 90° weir for measuring rate of outlet discharge.

has included the rate of discharge, the factors which affect discharge, adjustment, effect of trash in the water on the discharge rate, and the erosive characteristics. The need for more development was to be based on test data and observations. A second study was made of flume flow characteristics, including the effects of cross section, outlets, material, and misalignment.

Ten principal outlets were selected for testing. For the flume flow work with metal flumes, semicircular, rectangular, and trapezoidal cross sections are being used; with plastic flumes, semicircular cross sections are being used; and with concrete flumes, rectangular and trapezoidal cross sections are being used.

The detailed results of this project will appear in a forthcoming Special Release. Conclusions to date are as follows:

1. There are few, if any, outlets now used with metal flumes which will meet the maximum discharge requirements.

2. The partial clogging of outlets by trash in the irrigation water should be considered in designing outlets. The losses of flow have ranged from 26 to 81 per cent.

3. The effect of cross section on capacity has checked with calculations. In comparing semicircular and trapezoidal flumes on the basis of the same wetted perimeter and the same roughness coefficient, it was found that the trapezoidal had 27 per cent less capacity.

4. The reduction of flow because of slight misalignment becomes important on the steeper slopes.

5. An aluminum semicircular flume had two times the capacity of a trapezoidal concrete flume with the same wetted perimeter. The difference in this case was due to both cross section and roughness. The roughness coefficient for aluminum was found to be .0075, and for concrete .015 to .017.

VARIETIES

VARIETY TESTING FACES DIFFICULTIES

An intensification of the breeding program has brought about a more effective utilization, in crossing, of superior new parent canes. As a result, the number of new seedlings which appear worthy of preliminary testing on the plantations is at present larger than ever before.

Meanwhile, the difficulties which threaten the accuracy and add to the cost of harvesting variety tests and other field experiments have become more pressing year by year. It seems doubtful whether full returns from the breeding investment will be realized unless ways can be found to improve the precision and to reduce the cost and nuisance of harvesting field experiments.

In recognition of this need, an interdepartmental project has been authorized with the object of providing a concerted attack upon the problem. This project will seek to develop improvements both in harvesting procedures and in methods of evaluating cane quality.

1953–1954 CROSSING SEASON

Last season's crossing campaign, begun on November 16, 1953, was concluded on January 15, 1954. In spite of the fact that tasseling of certain of the "reluctant" late tasseling parents was adversely affected by the September drought, a good number of crosses was realized, as shown in Table IV.

Table IV
Number of Crosses Completed During 1953–1954 Crossing Season

General melting pot crosses	1,621
Leeward melting pot crosses	676
Elite melting pot crosses	439
Windward makai melting pot crosses	330
Windward mauka melting pot crosses	358
39–7028 sib melting pot crosses	77
Biparental crosses	637
Selfs	12
Field crosses	162
Field crosses involving new introductions in quarantine at the Mapulehu, Molokai Station	105
Total	4,417

PRELIMINARY TESTING AT REGIONAL STATIONS

The regional stations continue to operate at full capacity. The function of these stations is to receive the new seedlings germinated each year from crosses, and to carry them through the successive stages of preliminary testing (5 × 3, 5 × 6 and 10 × 15) with the object of identifying those which are worthy of testing on the plantations.

Table V shows the number of seedlings planted in each stage of testing at each of the regional stations during 1954.

Table V
Plantings made in 1954 at Regional Stations

Regional Stations	No. of Flats*	No. of Seedling Plots				
		5×3	5×6	10×15	20×20	30×30
Kailua Field Laboratory	2,624	4,005	1,036			
Waipio Substation	749	8,750**	2,759	172	92	
Waimano Mauka Var. Sta.	235	5,289	1,313	213	41	36
Ewa Variety Station	921	7,833***	986	68		18
Helemano Variety Station		4,090	1,842			
Helemano Makai Var. Sta.	227	2,851	999	83		30
Hilo Variety Station	500	3,142	1,845	104		24
Hamakua Makai Var. Sta.	350	2,270	1,915	87		33
Hamakua Mauka Var. Sta.	151	1,891	1,431	109		22
Kohala Variety Station	220	1,366	1,880	79		23
Kau Variety Station	200	3,876	1,571	100		22
Kauai Variety Station	333	2,488	1,522	130		39
Total	6,510	47,851	19,099	1,145	137	247

* No. of seedlings per flat—100 to 1000
** Includes 2332 plots already selected
*** Includes 5687 plots already selected

Omitted from the above tabulation are the following:

1. Breeding and spreading canes at the Kailua Field Laboratory
2. "Super" selections—2048 (5 × 3 plots)
3. Field nurseries under special conditions on plantations.

Lihue	272 flats
HC & S	206 "
Kohala	200 "
Olaa	201 "
Hawaiian Ag.	100 "
	979

4. 5 × 3 plots under special conditions on plantations.

Kohala	1442
Paauahu	307
Olaa	1332
Hawaiian Ag.	826
	3907

5. 5 × 6 plots under special conditions on plantations.

Kilauea	37
Kekaha	41
HC & S	481
Kohala	85
Hawaiian Ag.	72
	716

VARIETY TESTING ON PLANTATIONS

In the absence of adequate guard row protection, small plots in variety trials are vulnerable to border effect. The heavier the cane tonnage at harvest and the smaller the plot, the greater the likelihood that varietal competition will distort the yield figures to a point where they no longer reflect the true standing of the competing varieties.

In recognition of this source of error in preliminary variety tests, a number of plantations are standardizing on 40 × 40 plots (each plot 8 lines,

Table VI
Number of Preliminary Tests Installed by Plantations 1953–1954.
(Fiscal year ending June 30.)

Type of Test	Kauai	Oahu	Maui	Hawaii	Total
10×15 and 10×20	20	11	12	32	75
30×30 and 40×40	14	9	9	26	58

1600 square feet) to replace the 30 × 30 plots (6 lines, 900 square feet). To provide the increased amount of seed required by the 40 × 40 layout, the individual plots in the preceding stage of testing have been increased from 10 × 15 to 10 × 20. It is expected that these changes will be adopted by additional plantations during the coming year.

The number of preliminary tests installed by the plantations during the past year is shown in Table VI. The varieties which have been included in final tests installed by the plantations during the year are listed in Table VII.

Table VII
Replicated Variety Tests Installed by Plantations.
July 1, 1953 to June 30, 1954.

Variety	Kauai	Oahu	Maui	Hawaii	No. of Entries Total
H109	1	1	–	–	2
32 8560	–			1	1
37–1933	3	3	–	–	6
38–2915	4	1	–	6	11
4443	–		–	3	3
39 4753	1	–		–	1
7028	4	–	–	–	4
41–3340	–	–	–	3	3
43–1616	1		–	–	1
44–2772	–		–	4	4
3098	–			8	8
45–2120	4		–	1	5
2708	1	–	–	–	1
46–359	–	–	–	2	2
564	–	–	–	4	4
1463	1	–	–	–	1
2404	–	1		–	1
47–2060	3	1		–	4
48–152	–	–		3	3
546	–	–		1	1
3038	–	–	–	1	1
3166	1	–	–	1	2
49–104	–	–	–	2	2
118	–		–	1	1
134	–		–	5	5
722	–		–	1	1
784	–		–	1	1
Totals for:					
1953–1954	24	7	–	48	79
1952–1953	12	24	8	106	150
1951–1952	42	23	3	107	175

CYTOLOGICAL INVESTIGATIONS UNDER WAY AT BELTSVILLE

Dr. Samuel Price has continued his cytological investigation of sugar cane under the cooperative USDA-HSPA project.

Since the initiation of this project a year ago, Dr. Price has reported chromosome counts on 222 of the canes in the Kailua breeding collection. This study is beginning to throw light upon relationships among some of the groups of breeding canes. It has also helped to clarify several instances of mistaken identity.

DISTRIBUTION OF SEED

An essential function of the regional stations is the propagation of the seed of new seedlings of promise and the distribution of this seed to the plantations for preliminary testing and spreading.

The details of this regional station activity are shown in Table VIII.

Table VIII
Seed Shipments to Plantations.
July 1, 1953 to June 30, 1954.

Source	For Seed Nurseries in preparation for Replicated Tests—Tons	For Other Seed Nurseries —Tons	For Grade A and Special Tests— Tons	For 10 × 15 No. of Plots	For 30 × 30 No. of Plots
Kailua Field Laboratory	—	—	—	50	—
Waipio Substation	.73	4.74	1.43	2,495	29
Waimano Mauka Var. Sta.	—	.73	3.60	—	—
Hilo Variety Station	—	13.05	.03	1,013	2
Hamakua Makai Var. Sta.	—	.01	.05	899	1
Hamakua Mauka Var. Sta.	—	1.46	.03	122	1
Kohala Variety Station	—	.08	—	53	—
Kau Variety Station	—	.05	—	14	—
Kauai Variety Station	—	.08	—	—	—
Totals	.73	20.20	5.14	4,646	33

EVALUATION OF BREEDING BEHAVIOUR

Each year at the close of the selection season, a "Select List" is compiled summarizing the performance records of the new canes which have been advanced to the 10 × 15 and 30 × 30 stages of testing. Since the Select List records the parentage of each of the select seedlings, it helps to focus attention upon the more successful parents.

Table IX lists the parent canes which have contributed a substantial number of offspring to the 1954 Select List. As in previous years, 39–7028, 44–2364 and 44–3098 are outstanding both as to the number and the percentage of their offspring attaining the select status. Their superiority in this respect is particularly striking in comparison with

Table IX
Evaluation of Prominent Breeding Canes
(Based upon number and per cent of offspring in 1954 Select List)

Parent Variety	No. of Sdlgs. Germinated 1947–1951	Number in 10×15 and 30×30 trials	Selection Ratio 1 retained per—sdlgs.	Selection Per cent
32–8560	647,747	32	20,242	.005
37–1933	182,537	23	7,936	.013
38–2915	10,872	6	1,812	.055
39–3633	115,226	26	4,431	.023
4253	40,730	22	1,851	.054
4753	34,390	26	1,322	.076
7028	51,507	103	500	.200
41–3340	75,920	21	3,615	.028
3620	17,050	29	587	.170
44–640	29,150	19	1,534	.065
2364	75,321	110	668	.150
2772	6,892	6	1,148	.087
2818	29,111	16	1,819	.055
3098	42,124	133	316	.316
3228	13,520	12	1,126	.089
45–1361	6,050	6	1,008	.099
2120	27,420	19	1,443	.069
46–359	12,094	12	1,007	.099
919	2,250	16	140	.714
2404	4,320	11	392	.255
47–1914	17,900	35	511	.196
3756	1,050	7	150	.667
4991	2,360	8	295	.339

32–8560, which in its day was an outstanding parent.

Selection percentages tell only part of the story. Both 38–2915 and 47–4991 are satisfactory in this respect. However, because they are highly sterile, these two parents have yielded few seedlings in proportion to the effort expended upon them, thus resulting in disproportionately high per-seedling cost.

Of the several hundred new canes tested each year for breeding behavior, few are able to qualify as elite parents. A majority of the canes tested as parents produce no offspring of Select List caliber and must be dropped from the breeding collection.

In planning the crossing program, special attention is given to biparental crosses which bring together two elite parents, with particular emphasis on combinations in which the virtues and shortcomings of the two parents complement each other.

ACREAGE CENSUS OF CANE VARIETIES

The area planted during 1953 totalled 31,615 acres. This is 3463 acres less than the figure for 1952, and 12,278 acres less than the all-time record of 1951, when 43,893 acres were planted. This reduction in planting during 1953 may be attributed to improvements in harvesting procedures and to dry weather for harvesting. These favorable factors resulted in a reduction in field damage during harvesting and thus in a reduction in the amount of plowing and planting required to correct harvesting damage.

For the third consecutive year, 44–3098 headed the list of varieties planted. During 1953, 10,565 acres were planted to 44–3098, for the most part on the island of Hawaii. 37–1933 was a close second with 9452 acres, about half of which was planted on Kauai, one-fourth on Oahu and the remaining one-fourth on Maui. Third on the list was 38–2915 with 5923 acres, the bulk of which was planted on Maui and Hawaii. These three varieties accounted for 82 per cent of the acreage planted during 1953. The remainder was divided among the following,

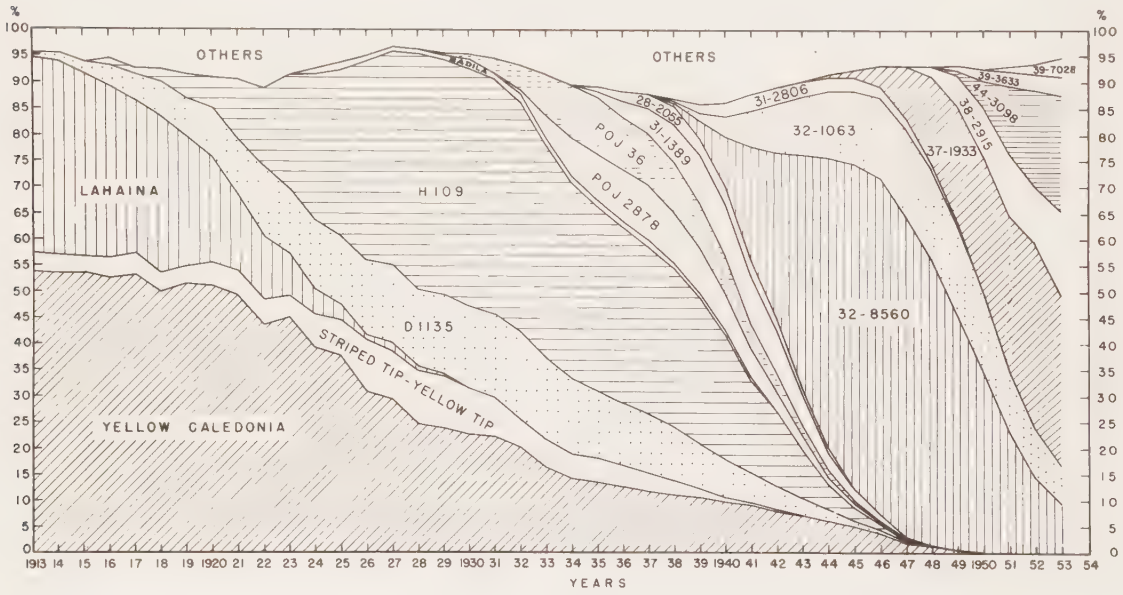


Figure 42. Varietal changes are here expressed in terms of per cent of total sugar cane area in Hawaii for the years 1913 to 1954.

listed in descending order of acreage planted: 39–7028, 39–3633, 32–8560, 38–4443, 41–3340, 39–4753, and 44–2772.

37–1933, with a total of.71,196 acres in plant and ratoons, remains the leading variety. This represents a gain of only 1610 acres during 1953, indicating that 37–1933 is nearing the zenith of its rise. (Figure 42)

In second place was 44–3098 with 48,443 acres, reflecting a gain during 1953 of 7863 acres.

38–2915 rose from fourth to third place with a gain of 3730 acres and a total of 35,485 acres.

32–8560 and 32–1063 in fourth and fifth places, respectively, continue to decline in acreage. 32–8560 lost 11,049 acres during 1953, while 32–1063 lost 4330 acres.

THE VARIETY PICTURE—1954

The following summary is based upon 30 × 30 tests harvested at the regional variety stations, and upon 30 × 30 and final tests harvested by the plantations. The major ecological zones will be considered in their geographical order beginning with Windward Kauai.

Windward Kauai—Makai Irrigated

37–1933 still serves as the standard in this district, but its heavy tasseling is recognized as a liability and a testing program is being actively prosecuted to identify suitable replacements. Meanwhile, 39–7028, a light tasseler, is being extended into the less fertile makai lands, particularly in fields which are to be started and harvested early enough to suffer heavy tasseling if planted to 37–1933. The advantage of freedom from tasseling offered by 39–7028 is somewhat offset by its slower starting and poorer juices.

44–3098 is still a competitor in the makai lands of Kilauea, but its performance at Lihue has been disappointing.

Candidates for further testing: 45–2120, 45–2608 (for mill-water fields and other heavy-tonnage, poor juice areas), 48–546, 48–3649, 48–4899, 49–5, 49–134, 49–3404, 49–3533, 49–3945 and 50–2606.

Windward Kauai—Middle Belt—Irrigated

Standard varieties in this region are 39–3633 and 44–3098, with some 37–1933 in the more fertile areas. 39–7028 is increasing in popularity here and is replacing the three standards to some extent.

Candidates for further testing: 45–1361, 45–2120, 46–1463, 48–546, 48–4899, 49–5, 49–134, 49–3404, 49–3533, 49–3945 and 50–2606.

Windward Kauai—Mauka Unirrigated

The standards here are 39–7028 and 38–2915. The latter has produced heavy tonnages in some of the mauka Hanamaulu fields, but the high incidence of red rot in this region is a source of concern.

Candidates for further trial: 39–4753, 45–2120, 49–3404 and 50–2746. (The scarcity of candidates points to the need for an intensification of 10 × 15 and 30 × 30 testing in this region.)

Leeward Irrigated—Mauka and Middle Belt

38–2915 is gaining strength as a standard for this region. In exceptionally fertile fields with adequate supplies of irrigation water, 37–1933 remains a strong competitor.

44–3098 has been less consistent than 38–2915 in field performance, and is being replaced by the latter.

Candidates for further testing: 47–2800 (for thin soils), 48–3649, 48–4646, 49–3404, 49–3533, 49–3637, 49–3666, 49–3856, 49–3998 and 49–4267.

Leeward Irrigated—Makai

This region remains the stronghold of 37–1933. Exceptions are to be found in the "growth failure" region of Central Maui and in areas of water shortage, where 38–2915 is preferred.

Candidates for further testing: 45–2608 (for mill-water fields and other areas having a history of heavy tonnages and poor juices), 47–2800 (for light tonnage and good juice areas), 48–3649, 48–4178, 48–4646, 49–2108, 49–3404, 49–3516, 49–3533, 49–3856, 49–3945 and 49–4267.

Hamakua and Kohala—Mauka

Under the cold, wet conditions of the extreme mauka zone, 38–4443 remains the standard. Its performance in the Kohala District has been somewhat more consistent than in Hamakua. 38–2915 continues to gain strength as the standard for the better mauka lands of Hamakua. 44–2772 is being

spread rapidly in the poorer areas of mauka Hamakua.

Candidates for further testing: 41–1045. (40–2069 and 46-564 may be classed as standby varieties.) Desire for additional competitors for 38–2915 has stimulated an active testing program in this region.

Hamakua and Kohala—Middle

Here the standards are 38–2915, 39–4753 (especially in Kohala), 41–3340 and 44–3098. 38–2915 is generally preferred for average conditions (except at Honokaa) with 39–4753 in the poorer windswept areas and 41–3340 in droughty situations. The performance of 44–3098 in this region has been somewhat erratic.

Candidates for further testing: 40–2069, 41–1045, 45–2120, 45–2654, 46–564, 48–546, 49–5, 49–104 and 49–134.

Hamakua and Kohala—Makai

Standard varieties are 38–2915 (both irrigated and unirrigated), 41–3340 (both irrigated and unirrigated, but especially under droughty conditions) and 44–3098 (except in situations liable to drought). 32–8560 continues to be grown in this zone at Honokaa. Some 45–2120 has also been planted in this region.

Candidates for further testing: 45–2120, 46–564 (for droughty spots), 48-527, 48–546, 49–5, 49–104 and 49–134.

Hilo—Mauka

44–3098 is the standard except in the Laupahoehoe end of this region where 38–2915 is preferred.

Candidates for further testing: 44–2772 (as a replacement for 38–2915), 45–2654, 46–525, 46–564 and 50–723.

Hilo—Middle and Makai

Here 44–3098 sets a high standard. 39–3633 is still being grown to a limited extent on the better lands. 45–2708 may be classed as a standby for the better makai lands.

Candidates for further testing: 44–2507, 46–525, 48–152, 48–527, 49–104, 49–134 and 50–2036.

Kau—Mauka

The standard, 44–3098, appears particularly well adapted to this region and continues to give good yields. In the lower portion of this zone, 38–2915 is planted to some extent in well drained areas.

Candidates for further testing: 44–2772 and 49–118.

Kau—Middle

Here, also, 44–3098 is a strong standard. 38–2915 is planted in areas regarded as too droughty for 44–3098.

Candidates for further testing: 41–1045, 44–2772, 46–564, 49–118, 49–134 and 49–784.

Kau—Makai

Because of its drought resistance, 41–3340 is being adopted as a standard in the drier fields formerly occupied by 32–8560.

Candidates for further testing: 45–2120, 46–564 and 47–1914.

FLOWERING CONTROLLED BY WITHDRAWAL OF WATER AND WITH CHEMICALS

Two practical methods of flower inhibition are withdrawal of irrigation water and chemical sprays. A more detailed study of their effects has been made by the Department of Physiology and Biochemistry.

Figure 43 shows five dated stalks which were prevented from flowering by withdrawal of water between August 11 and October 1. As stated in Special Releases 98 and 102, about six weeks of hot, dry weather without irrigation are required for complete flower inhibition in young cane at Makiki. This prolonged drought results in reduced growth as shown in Figure 44. With the final irrigation on August 11, growth is greatly reduced in late August. September growth is reduced to about one-third normal. After water is again applied on October 1, there is an increase in growth rate for a while during that month. However, the drought effects are again seen in slow growth in November. This may be due to deleterious effects on cell divisions during September.

At the Makiki Station, a number of new chemicals were tried for flower inhibition. Some of these show promise and are being used on a larger scale this year.

Figure 45 contrasts a plant sprayed with maleic

Figure. 43. Five stalks, dated early August, late August, September, early October and late October, did not tassel because irrigation water was withdrawn.

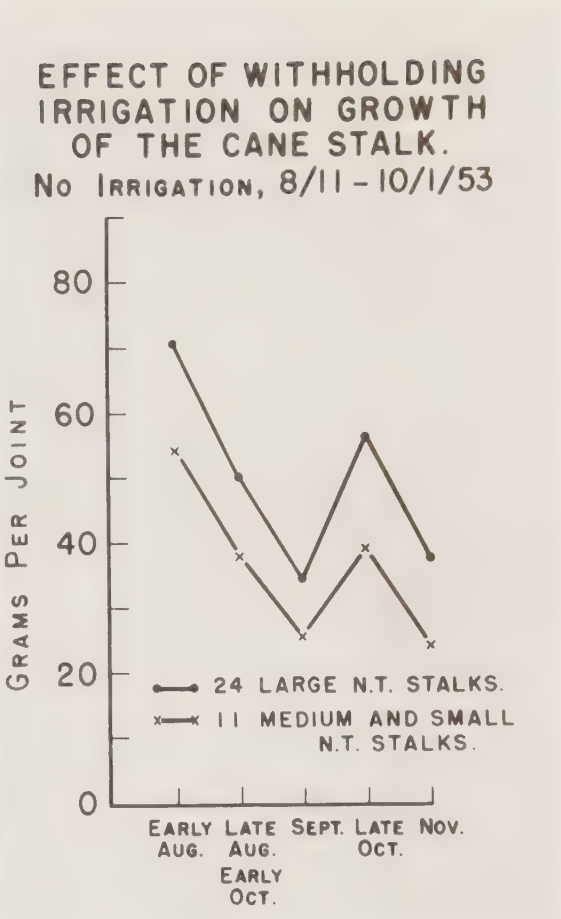


Figure 44. When water is withheld during August and September to inhibit flowering in variety 37–1933, the rate of growth is sharply reduced.

hydrazide and its unsprayed control. Although MH is commonly called an anti-auxin, or growth inhibitor, it has not materially lessened the growth, while it has prevented flowering.

Tassel counts made on various test plots at the Makiki Station bring out the following points:

1. High nitrogen reduced tasseling about 20 per cent when compared with low nitrogen plots.

2. There are more, and earlier, tassels at Manoa than at Makiki.

3. In pot tests, more tassels were on the makai side.

4. Shade (20 per cent of full sun) and high humidity did not induce tassels in seven reluctant varieties. 37–1933 controls flowered late, i.e., the tassels emerged slowly.

EFFECTS OF RADIATION ON SUGAR CANE

In cooperation with the Physiology and Biochemistry Department, further attempts were made to induce flowers in the reluctant variety, 39–7028, by treatment with gamma rays from cobalt 60. Again this failed at all levels of dosage used. However, effects on the young growing tips resulted in striking changes in subsequent growth as shown in Figures 46 and 47. The entire portion of stalk

Figure 45. The stalk on the left, sprayed with maleic hydrazide, has a normal spindle with no flower. Its control has a well-developed flower about to emerge. The plant was sprayed on August 20 and photographed on November 10, 1953. The portions of the stalks which are shown have grown since September 10.

Figure 46. Exposure to cobalt 60 gamma rays with very high doses results either in lala production or in the death of the terminal bud.

Figure 47. Prolonged exposure to low intensities of cobalt 60 gamma rays may result in excessive lala production.

photographed has grown since the treatment of the growing tip. The smaller doses do not materially reduce total growth, but they do overcome the dominance of the terminal bud with resulting lala production.

Prolonged mild radiation produces the excessive lalas seen in Figure 47. Very high dosages reduce growth and kill the terminal bud as seen in the cane at the left in Figure 46.

Irradiation of germinating seed pieces is being continued with the expectation of producing some mutations which may be of interest. After treatment, young plants are transplanted to plots in Kailua for future observation.

FIELD EXPERIMENT TECHNIQUES NEED MODERNIZING

Present wage levels demand that field experiment techniques be reappraised with the aim of reducing costs and of safeguarding or improving accuracy. This will entail a re-examination of such factors as plot size and shape, methods of harvesting, weighing and sampling, and analytical procedures for determining cane quality.

Some of the aspects of harvesting field experiments are shown in the accompanying figures.

On the island of Hawaii, the mobile, trailer-mounted Cuban A mill several years ago replaced the old nutcracker sampler as a means of obtaining juice samples from experimental plots. (Figure 48) Investigations by the Sugar Technology Department indicate that the accuracy of cane quality determinations may be further improved by means of their newly-developed silage cutter-disintegrator method.

At Lihue, experiments have been successfully harvested with the Duncan cutter. (Figure 49) This procedure requires a slash-cut plot boundary across the lines at each end of the plot. The actual area harvested must be determined when the machine has completed its last pass. The usual procedure is to harvest for yield the four center lines only of an eight-line plot.

Figure 50 illustrates a preharvest, level-ditch boundary separation in preparation for harvesting experiment plots with the Duncan cutter.

At Waipio, a small loader is used with trucks of a suitable size for handling the cane from 30 × 30 plots. The grab illustrated in Figure 51 is hydraulically operated.

As shown in Figure 52, lengths of cane are inserted vertically through the load. This prevents shifting and loss of cane en route to the scale.

Figure 48. The Cuban A mill, mounted on a trailer, obtains juice samples from experimental plots.

Figure 49. The Duncan cutter harvests experiments successfully at Lihue.

Figure 50. Experiment plots are prepared for harvesting by means of level-ditch boundary separation.

Figure 51. A grab, hydraulically operated, loads the cut cane into trucks.

Figure 52. Lengths of cane are used like pins to prevent loss of cane en route to the scale.

WATER DEVELOPMENT

BEACH ROCK DISTRIBUTION INVESTIGATED

A study of the distribution and nature of Hawaiian beach rock (cemented calcareous beach sand), made with K. O. Emory of the University of Southern California, has indicated that beach rock may form in response to the evaporation and pH changes in sea water in the beach, contrary to an older theory that fresh water escaping through the beach was essential. Fresh water is commonly so far from saturation that it acts as a deterrent to the formation of beach rock except where it has passed through a considerable limestone area. No beach rock has been found in the process of formation. The Hawaiian beach rock seems to date, at at least in part, from a period a couple of thousand years ago when sea level was several feet lower than at present.

KILAUEA ERUPTED

Early on the morning of May 31, 1954, Kilauea volcano erupted through two rifts, one crossing the floor of Halemaumau and extending part way up the northeast side of the pit, the other, about a mile long, crossing part of the floor of Kilauea crater itself, northeast of Halemaumau.

By noon of the same day, the most vigorous part of the eruption was over, and activity ceased on June 3. Geologic assistance was given to the Volcano Observatory during the early stages of the eruption, until it was apparent that activity was diminishing.

WATER SUPPLIES AFFECTED BY 1953–54 DROUGHT

The extreme drought that began in early 1953 persisted until May 1954. With the rains since, surface-water supplies have improved and surface-water storage has increased to an unusual high for the time of year.

Because of their larger storage capacities, basal ground-water bodies have not responded so quickly. Some pumps were still losing suction late in the summer, and some wells were giving water of record high-salinity into the fall. If the rainfall continues high, further improvement can be expected next year, but it will take many years to wipe out the effects of the cumulative deficiency, and another year of subnormal rainfall might now easily create conditions worse then those in the past year.

Probably most seriously affected is the mill well at Lahaina, which supplies water used first for cooling purposes and cane cleaning at the factory, and afterwards for irrigation and transport of soil from the cane cleaner. Water from this well has exceeded 2700 ppm Cl (260 gr. NaCl/gal.), but it is at present the only water available for irrigating some fields. Because of the continuing water requirements of the factory, the draft cannot be reduced to try to improve the quality. Additional development possibilities are under study, though no easy remedy is seen.

Figure 53. Drilling the Spreckelsville mixing-zone test well.

Figure 54. Excavating the pit of the Spreckelsville well.

THE SPRECKELSVILLE WELL TO TEST MIXING ZONE

In order to investigate the nature of the zone of mixture at the bottom of the Ghyben-Herzberg lens and to evaluate the importance of bottom lag, HC & S has had a special test well drilled near Spreckelsville, on the north coast of the Isthmus, where the static head averages about two feet. The well, eight inches in diameter and 229 feet deep, was drilled within a pit carried from the surface at 14-foot elevation to two feet below mean sea level. (Figures 53 and 54) It has been cased with 14 flexible plastic pipes of various lengths, each finely perforated at the bottom. The pipes were weighted by a concrete cylinder cast around the bottom of the deepest one, and were taped together as they went down, to make a single package. The hole was then filled with fine crushed rock around the pipes to 15 feet below sea level.

It is intended that when the installation is completed, the pipes will flow continuously by gravity into a small sump in the pit, the flow being valved to a trickle. A small pump will drain the sump, discharging the water 800 feet seaward. Water-stage recorders will plot the fluctuation of water in the upper, unfilled part of the well, and in any selected one or two of the deep pipes. Salinity sampling will probably be done weekly.

PAHALA SHAFT WATER LEVEL DROPPED

In 1951, a great rise in water level at the Pahala shaft of Hawaiian Agricultural necessitated raising the pumps. In 1953 and 1954, the trend was strongly reversed, and a race developed between the lowering water level and the reconstruction of a flume line that would reduce or obviate the use of one set of horizontal centrifugal pumps that would be rendered useless by an extreme drop. A previous correlation of water level with rainfall was extended to predict that the water level might drop beyond reach of the pumps before the end of the year, but not before the flume could be rebuilt.

Figure 55. During a recharge test of the Lawai well, the water level is being checked by cable while water is being run into the well through the pipe.

WATER-LEVEL MEASUREMENTS IMPROVED

Several new water-level recorders were installed on wells and test holes, of which the most important are: a permanent U. S. Geological Survey gauge replacing the Geology Department gauge in the Ookala well at Kaiwiki that serves as key well on the Hamakua Coast; and a Maui County Waterworks Board recorder on a test hole in the ground-water body that supplies the Wailuku shaft as well as the new County wells.

A standard U. S. Coast and Geodetic Survey tide gauge, to be maintained by Lihue, is being installed at Nawiliwili. This will supplant the Port Allen portable tide gauge operated for several years by McBryde Sugar Company, Ltd.

A recorder was operated briefly on an abandoned well at Pepeekeo, in the hopes that it might prove satisfactory as a key well on the Hilo Coast. However, the well was found to be dropping perched water to recharge the basal water, and the water level in the well, which had a high variation both diurnal and longer term, was representative of neither ground-water body.

PEARL HARBOR BASAL GROUND-WATER DATA COMPILATION

Ewa has begun authenticating and compiling old ground-water records, with the advice of the Geology Department. In view of an increasing draft and increasing need for water in the Pearl Harbor area, such a review and a coordinated study by all parties concerned appear of critical importance.

LAWAI WELL DRILLED AT McBRYDE

A new 720-foot well for McBryde was drilled at Lawai between October 1953 and February 1954. Two unexpected developments slowed the construction. First, the driller encountered such hard rock immediately below the surface that a 55-foot shaft had to be sunk before the actual drilling could be started. Second, the well penetrated a three-foot cavity at a depth of 440 feet, probably a lava tube,

which drained the water to a level lower than either the level of perched water which penetrated higher in the hole, or the level of basal water eventually reached. Probably the lava tube drained a zone of otherwise low permeability between the two aquifers, discharging makai across a buried cliff into a different series of lava flows in which there is a still lower head. The lava tube was cased off, but 800 bags of cement were necessary to grout the casing in place.

A recharge test when the well was completed indicated a very high specific capacity, and a five mgd pump is on order for installation late in the year. (Figure 55)

LIHUE SEARCHES FOR WATER BETWEEN KEALIA AND MOLOAA

Lihue conducted a diamond-drilling campaign between November 1953 and August 1954, to investigate the possibilities of ground-water supply to lands between Kealia and Moloaa. Six holes were drilled, totalling more than 3000 feet.

The first four holes were in the area between Kealia and Anahola, which has a deficient surface-water supply in dry weather. Basal water with a head of 15 feet above sea level, and perched water with a head of 215 feet above sea level, were demonstrated by two holes in the younger series of rocks underlying the cane lands of the area. One of these holes was carried to a depth of 325 feet below sea level in an unsuccessful effort to find the underlying older series of rocks of the island. However, two mauka holes demonstrated basal water with a head 60 to 70 feet above sea level in the older series, and a site for well-drilling was recommended.

The remaining two holes were drilled to investigate possible ground-water supplies for cane irrigation in the lands between Anahola and Moloaa, hitherto in pineapples. The first was barely unsuccessful in testing the potentials in the older series of rocks, apparently passing close to a near-vertical buried cliff for over 600 feet. The second demonstrated a 50-foot head, but rather low permeability. Step-by-step development has been recommended.

LIHUE SEEKS ROAD MATERIALS

A study has been made of the availability at Lihue of material suitable for surfacing access roads and cane haulage roads in case trucking is substituted for railroading. A volcanic cone, Hanahanapuni, was opened up in a search for cinders, but the cinders were found to be too weathered to be of any use. Some fresh spatter has, however, been mined from it for roads in the vicinity. Most of the other types of material available on land have been found to exist in too small quantities, or to be too expensive to mine and process. Coral from the ocean, particularly from a reef at Kapaa, appears promising as a road material if the road construction program will permit a large-scale dredging operation, and an exploration program has been recommended. The study of coral prospects was made with F. P. Shepard of the Scripps Institution of Oceanography.

WHAT IS HAPPENING AT SPRECKELSVILLE BEACH?

A survey was made, with F. P. Shepard and K. O. Emory, of beaches in the vicinity of Spreckelsville from which large volumes of sand have been mined for lime production, concrete, and road surfacing. The beaches have been receding, and an estimate was sought for the amount of sand that could be mined without further damage to the beach. (Figure 56) The problem is typical of many beach problems in Hawaii. There is heavy mining from, and concurrent retreat of, many beaches, particularly on Oahu, but the effects of the mining cannot satisfactorily be estimated because of lack of knowledge of the effects of changes in natural conditions which are simultaneously causing retreat in many places.

The Spreckelsville problem, like these others,

Figure 56. The beach at Kapukaulua, near Spreckelsville, shows effects of retreat. The coconut palms and other trees used to be well inland.

cannot be solved without a full-scale study of all of the factors governing the supply of sand to, and removal of sand from, the beaches. The economic importance of their solution gives rise to hopes that suitable personnel may in some manner become available for work on these problems in the near future. In the meantime, a program of measurements has been recommended at Spreckelsville that will fit into the study that must finally be made there.

WEATHER

MICROMETEOROLOGICAL STATION INSTALLED AT WAIPIO

An elaborate experiment has been installed by the HSPA-PRI Meteorology Department as part of an evapotranspiration project being conducted in cooperation with the Agronomy Departments of these organizations. This experiment, located on the Pineapple Research Institute Substation grounds at Waipio, is designed to evaluate the effects of meteorological conditions on the evapotranspiration of water from an open water surface, from bare soil, and from soil covered by grass, sugar cane and pineapple. Some of the objectives of the research are: to determine to what degree the need for irrigation can be defined from meteorological data alone; to provide methods for more accurate estimation of moisture requirements in different climatic zones; and to investigate in detail the effects of variations in sunlight, temperature, humidity, soil moisture and wind, on plants in natural growing conditions.

Figures 57 and 58 depict various parts of the experiment installation. Four evapotranspiration tanks have been placed in the ground. Soil has been carefully replaced in them to duplicate as nearly as possible the surrounding natural soil conditions. Moisture placed on the surface of the tank can percolate through the soil and be drained off into a sump house where the unused, percolated water can be measured. The actual moisture in the soil can also be measured. Bookkeeping procedures will permit an evaluation of the amounts of water placed on the soil, percolated through the soil, and in the soil, so that the net amount of water consumed through evaporation and transpiration can be computed. To obtain a continuous record of moisture consumption through evaporation and transpiration, one of the evapotranspiration tanks is being suspended on load cells—strain gauges whose resistance is a function of weight.

Meteorological data—wind, temperature and humidity—are being measured at several levels above the ground to determine the effects on moisture consumption of these factors in the surface layers near the ground. With the use of these instruments, it will be possible to compute the mean transport of moisture upward through the air from the ground surface. A continuous record of these measurements will be kept by electronic recording apparatus in the instrument house shown in Figure 58.

Continuous sunlight measurements are being made by the use of two separate types of instruments. For comparison purposes, a standard water evaporation pan has been installed, with associated wind and rainfall measuring devices.

The first preliminary data from this experiment should be available in the fall of 1955, and the first crop data during the following year.

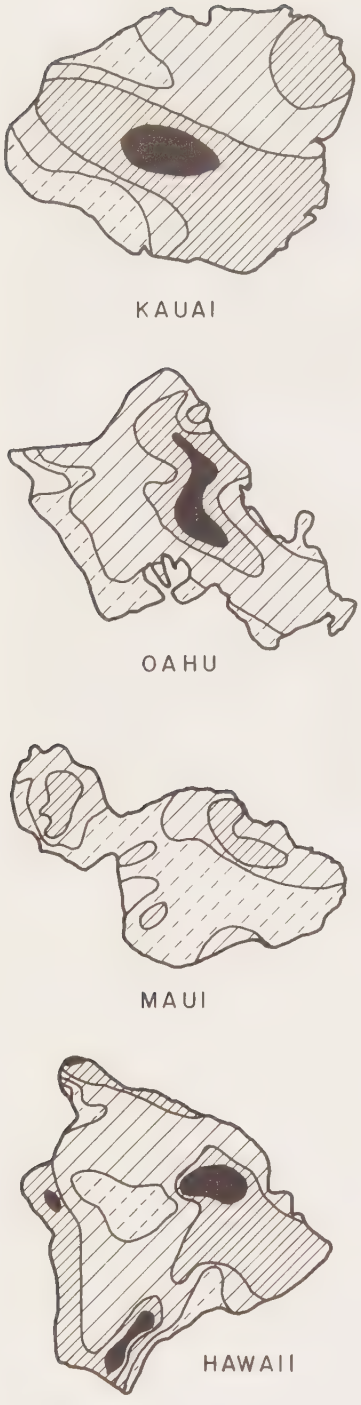
TWO-YEAR DROUGHT HAMPERS SUGAR CANE PRODUCTION

Nearly all of the Territory of Hawaii suffered from a severe deficiency of rainfall as a result of more than two years of drought. (Figure 59) It is extremely abnormal for *all* areas in the Islands to be deficient during any extended interval, so that this two-year drought with less than 25 per cent of normal rainfall for some areas was one of the most serious in Hawaiian history. Only regions of relatively high normal rainfall received a sizeable proportion of their average rainfall for this period. Most areas received under 50 per cent. Even these figures, however, do not give a true picture of the severity of the extended dry weather. Occurrences of rain were few and in most instances moderately intense,

Figures 57 and 58. The HSPA-PRI Meteorology Department, in cooperation with the Agronomy Departments of both institutions, has set up an experiment at Waipio to determine how meteorological conditions affect evapotranspiration of water and to what degree the need for irrigation can be determined from meteorological data. Tests will be run with an open-water surface, with an area of bare soil, and with plots planted to grass, sugar cane, and pineapple.

Figure 57 shows part of the experimental installation. At the right center is an evapotranspiration tank. These tanks are five feet square, and after they are placed in the ground, they are filled with soil in as close an approximation as possible of the stratification and densities normal to that location. The wires showing on the surface lead to nylon and plaster of Paris blocks which measure soil moisture at six-inch intervals in depth. Water which percolates through this tank is drained through pipes into the sump house in the foreground. Just beyond the tank, in the fenced area, is a standard evaporation pan installation. At the rear is a recorder house which contains both standard and specialized meteorological instruments.

Figure 58 shows the sunlight-sensing elements on the roof of the recorder house, while inside are several instruments which continuously record measurements on the tower, evapotranspiration from one of the tanks, intensity of sunlight and other meteorological variables.



so that long periods occurred when there was absolutely no rain in some areas. Beginning in February 1954, however, rainfall increased generally, until during the summer of 1954, most areas had a three-month rainfall total well above the usual summer rainfall.

Because of the adverse effects of dry weather on young cane, the full effects of the drought probably cannot be appraised until 1956.

ARTIFICIAL RAINFALL EXPERIMENTS CENTER ON GROUND SEEDING POSSIBILITIES

During the past year, measurements of the water-yielding potential of Hawaiian clouds and the frequency of occurrence of clouds obtained by the Meteorology Department indicate that, thus far, seeding clouds from an aircraft is an impractical undertaking. Although artificial rainfall has been produced in measureable amounts by this method, the amounts of rainfall so far either produced or considered theoretically possible, according to current techniques and data, seem too small to be of economic importance. However, if larger amounts of seeding material can be placed in clouds in frequently-clouded areas, it seems possible that practical results might be obtained.

One of the best sites for evaluating this possibility exists in the Keanae Valley in the East Maui watershed area. Here it appears possible to introduce large amounts of water spray directly into the cloud from the ground. A pilot experiment of this type has been undertaken in cooperation with the East Maui Irrigation Company. During the past summer, Ben K. Seely, on loan from the New Mexico Institute of Mining and Technology, and staff members of the Meteorology Department have conducted a series of experiments designed to measure the dispersal and growth of the water droplets sprayed directly into the cloud base at the Keanae Valley site.

Figure 59. A two-year record of island rainfall shows nearly all areas gravely deficient in rainfall.

Figures 60 through 63 illustrate the plan of the ground seeding experiment in the Keanae Valley on East Maui.

In Figure 60 the normal wind direction is from left to right. In the center foreground, the ridge jutting out into the valley serves to support spray apparatus. As the winds rise on the slopes, they carry water sprays up into the clouds and then on to the watershed area downwind.

Typical cloud conditions are shown in Figure 61. The cloud area at the left is in a rapidly rising current of air.

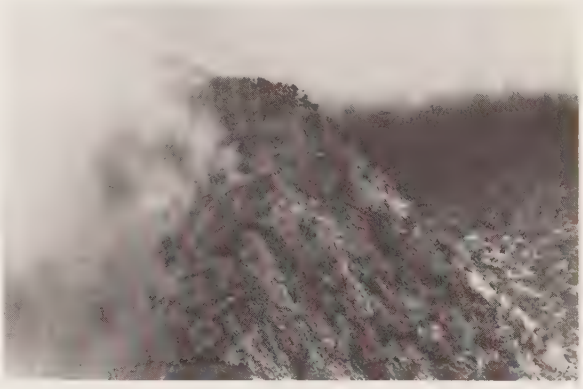


Figure 62 shows the site of the pilot experiment as it is now installed. If the experiment proves practical, a large installation of this kind will be constructed.

Figure 63 shows the area which is likely to be affected by the experiment.

Although several open questions remain, results of the experiment to date are quite encouraging. An increase of approximately 200 times the amount of water sprayed resulted from the very small quantities of water used to date. Until more practical estimates of the efficiency of the experiment in larger scale operation can be obtained, the economics of the method remain uncertain. If such results bear out the preliminary data, however, it appears that an appreciable amount of additional rainfall may be obtained in this area by extending this technique. Figures 60 through 63 show the design and techniques of the pilot experiment conducted this past summer.

WEATHER FORECASTING AND CLOUD PHYSICS RESEARCH ORGANIZATIONS VISITED ABROAD

Wendell Mordy spent several months in Australia, Sweden, England, and continental United States, visiting research organizations engaged in meteorological work related to the program of the Meteorology Department.

At the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization in Australia, he was able to observe the extensive cloud seeding and cloud physics research program of that organization.

The cloud physics program of the Radiophysics Laboratory is one of the strongest in the world. Over a period of eight years, the Australian government has sponsored this research on a scale which has only recently been duplicated in the United States. To date, however, no direct, practical application of cloud seeding in Australia has been undertaken.

In Melbourne, Mr. Mordy visited the Meteorological Physics Group of the Commonwealth Scientific and Industrial Research Organization. This group is engaged primarily in meteorological research affecting the transfer of heat and water vapor in the lower layers of the atmosphere. This is fundamental work related to the problems of evaporation and transpiration and cloud formation, among others. This group also is a strong scientific team made up primarily of European scientists who have emigrated to Australia since the war. The largest part of the work thus far has consisted of the development of instrumental techniques for measuring the minute details of turbulence phenomena. One of the outgrowths of this particular work has been the successful development of an instrument which measures evaporation directly.

Mr. Mordy spent several weeks in Sweden at the invitation of Professor C. G. Rossby of the Institute of Meteorology of the University of Stockholm. Their main interests at present are numerical weather forecasting and atmospheric chemistry. Current forecasting research is directed primarily toward the development of mechanical forecasting techniques, using electronic computing machines. This is the Swedish counterpart of the current meteorological research at the Institute for Advanced Study at Princeton. This work has progressed to the point where, by means of straightforward though enormously complex mathematical computations, prognostic weather charts can be produced directly from the electronic computer.

In England, Mr. Mordy visited the cloud physics research team at The Imperial College of Science and Technology, London.

On the mainland, Mr. Mordy visited the Woods Hole Oceanographic Institute, the Munitalp Foundation Research Laboratory, the University of Chicago where perhaps the largest cloud physics program in the world has been under way for a year and a half, the Meteorology Department at the University of California at Los Angeles and the Scripps Institution of Oceanography.

WEED CONTROL

WEED CONTROL COURSE POPULAR

A comprehensive three-day course in weed control, designed originally for the instruction of the trainees at the Experiment Station, was expanded to include past trainees, plantation agriculturists, executive members of the agencies, and executive officials of the plantations.

The course, presented by actual demonstrations, consisted of a review of chemical weed control from its inception on the island of Hawaii in 1907, up to and including the very latest chemical developments on the mainland and the development by the Chemistry Department of formulations of these chemicals for plantation use.

The course served so useful a purpose that it will be repeated once a year in order to keep trainees and plantation workers up to date on the most recent developments in the science and art of weed control.

THIN EMULSIONS FOR DISPERSING WATER-INSOLUBLE PRE-EMERGENCE CHEMICALS

As has been often stated, CADE and ARCADE emulsions are the only practical vehicles so far found for the permanent and quantitative suspension of insoluble herbicide constituents such as CMU, PMU, and DCMU, which have been very finely pulverized and which, in most cases, are intended only for pre-emergence application to bare soil. Standard CADE and standard ARCADE may be used for this purpose without being diluted, provided the application is to be made by aircraft. Otherwise, a thinner type of emulsion does a better job. However, the thinning operation must not be carried to the point where the density, viscosity, or adhesive character of the emulsion will no longer be able to sustain the suspension of pulverized chemical.

A spontaneous emulsion was developed to enable plantation workers to suspend a number of pre-emergence chemicals in CADE- and ARCADE-type emulsions when a centrally located mixing plant equipped with homogenizers or other mechanical aids is not available. The emulsion produced is, of course, a temporary one, and must be applied promptly. An aqueous solution of the emulsifying agent and stabilizer is placed in a barrel or drum and, while it is being stirred vigorously with a paddle, the herbicide is introduced as a wettable powder. The oil is then added in a slow, steady stream. The resulting emulsion suspends the chemical and remains stable long enough to permit application by ground equipment in nearby field areas.

HYDROPHILIC (WATER-LOVING) HERBICIDE OILS FOR CONTACT SPRAYS

The use of oils, particularly aromatic oils, for contact applications on persistent grasses on certain areas of the plantations has been rather general throughout the industry. However, plantation men have reported that, although the aromatic oils are doing a good job on some grasses, their potency needs to be bolstered by the addition of other contact substances. In many cases, the contact

substances selected are not soluble in oil, so that a uniform mixture of the two constituents cannot be made. To meet this situation, the Chemistry Department developed a hydrophilic oil concentrate which can be added to the bulk aromatic oil. This makes it possible to incorporate with the oil a water solution of the desired chemical in an emulsion-like mixture which meets requirements.

LOW-VOLATILE ESTERS OF 2,4,5–T SHOW PROMISE

Low-volatile esters of 2,4,5–T have shown considerable promise in competition with other types of the newer pre-emergence chemicals. Their employment has become standard practice on at least one large sugar plantation. Formulations have been developed at this Station whereby the untreated esters are processed into liquid concentrates carrying four pounds of the acid equivalent of 2,4,5–T per gallon.

Two types of concentrates are now available for plantation use. One is formulated so that it may be diluted with water to any desired volume for application in the field. Precautions have been taken in developing this formulation to insure an even distribution of the emulsified concentrate in the water vehicle. Another concentrate has been developed for use exclusively by dilution with either Diesel or an aromatic oil for field application. The field man dilutes a gallon of the concentrate with 19 gallons of either water or oil, as the case may be, for application by land-operated equipment to one acre of bare ground, after the sugar cane seed pieces have been planted and covered and before any noticeable weed or grass growth has appeared. In several cases, reports from plantations doing this work either as standard practice or on an experimental basis, have indicated that a control of from 8 to 10 weeks may be expected.

OIL DISPERSION OF AQUEOUS SOLUTIONS OF AMINE FORMS OF 2,4–D

An emulsifier having non-ionic characteristics was incorporated with a water solution of triethanolamine and monoethylamine concentrates of 2,4–D, and to this solution an aromatic oil was introduced in a slow, steady stream, with vigorous agitation.

A NEW CONTACT AND PRE-EMERGENCE CHEMICAL—3,4–D—APPEARS

While 3,4–D contains the same number and the same kind of atoms found in 2,4–D, it carries one chlorine atom in a different position in the ring structure of the molecule. Chlorine in 2,4–D occupies the No. 2 position in the benzene ring. In 3,4–D, it is moved down to the No. 3 position. This slight variation introduces a remarkable change in the physical and chemical properties of this compound. It is now being studied at this Experiment Station and, under Station supervision or direction, on many of the plantations.

Screening tests in Honolulu showed that 3,4–D is effective on both grasses and broadleaf weeds. It also resists leaching from the soil when applied as the soluble sodium salt in pre-emergence. In an experimental study comparing 2,4–D with 3,4–D applied directly to the foliage of tomato plants at from 5 to 50 ppm in a distinct sequence, rather striking results were secured. The tomato plants treated with 2,4–D were seriously injured, suffering epinastic effects on the stems and leaves, and producing very few, nubbin-like tomatoes. In contrast, 3,4–D, at the same dosages, had little, if any, effect on the tomato plants. In addition, the formation, development, and ripening of an unusually heavy yield of fruit apparently was not affected in any way. The tomatoes were large, well-formed, and very solid.

So far, the use of the sodium salt of 3,4–D in pre-emergence applications on the plantations gives some indication that the amount per acre required, for a satisfactory effect over a period of a month or two, will have to be double or treble the dosages used in greenhouse pot studies in Honolulu. This research will be continued when additional supplies of the chemical are available.

LIMITATIONS OF 2,4-D SHOW UP

Recent observations support the results of studies made at the State College of Pennsylvania which indicated that 2,4–D loses its potency when it is applied to the soil in pre-emergence, crop after crop, over a period of five or six years. One observation was made on a plantation where, about five years ago, the effective interval of control from 2,4–D applications averaged six weeks. Today, on the same areas and at the same dosages with the same forms of 2,4–D, the control is not only erratic but seldom exceeds a period of about 10 days. Observations made on other plantations tend to support the belief that the bacteria which decompose 2,4–D have built up in the soil over a period of years. Where 2,4–D has been applied regularly, it is rapidly consumed as a result of the increased number and activity of the bacteria. As a consequence, the effective interval of its function suffers accordingly.

On the other hand, the efficiency of 2,4–D applied in an aqueous solution on growing vegetation, particularly on broadleaf weeds, does not appear to have diminished to any observable extent. Its effectiveness in the form of the sodium salt, when combined with contact chemicals, also is giving satisfactory results generally throughout the plantations on all of the islands. It is being used more extensively than ever before.

SCREENING TESTS OF NEW HERBICIDE CHEMICALS REPORTED REGULARLY

At the beginning of this year, the Chemistry Department undertook to review and report the results of screening tests on all of the new chemical developments which have been studied at the Experiment Station. These reports appear regularly in the Monthly Report, which is distributed to members of the Association. These reports will continue to carry findings on all chemicals studied, including not only those which have proved outstanding and worthy of further study, but also those which are mediocre, definitely inferior, or worthless. The purpose is to keep members of the Association informed of the good, medium, and poor types of compounds studied, to acquaint them with the names and properties of these materials, and to furnish them with briefly worded and complete resumes of what they may expect to accomplish if they use these chemicals experimentally.

Response by plantation men to this type of reporting has indeed been encouraging.

HSPA INHIBITOR OF CORROSION PROVED EFFECTIVE

The HSPA inhibitor of corrosion, which is now about three years old, is being used rather generally by plantation men in stabilizing the corrosive chemical compounds used in weed control and for other purposes. It has also proved very effective and economical in protecting the metal mixing equipment, storage tanks, and spraying equipment in use on the plantation premises. Characteristics and properties of this development have been described in previous Annual Reports. Up to June of this year, four tons of the inhibitor have been manufactured at the Experiment Station and supplied to plantations as needs for it developed and as its usage became more general.

The HSPA inhibitor has the property of buffering and stabilizing solutions of the sodium salt of various acids and of maintaining the normal pH of such solutions for an extended period of time. When such solutions are incorporated with others, such as the sodium salt of 2,4–D, and when these solutions are stored in metal tanks, the pH is maintained at a value of about 7.5 to 8.0. As a consequence, since no chemical action takes place on the metal container and no acidity is developed, the solution of the sodium salt of 2,4–D remains as such and does not revert to the acid form and precipitate out of solution.

As a protective addition in fertilizer solutions, the inhibitor has very wide value. Experimental studies on a plantation scale are now being made

in connection with the growing use of water solutions of fertilizers, not only for application by air, but in the ditch systems of irrigated plantations.

The HSPA inhibitor definitely arrests reduction of organic mercurials, even at very low concentrations of these compounds, when they are processed, stored, and used in plantation practice in metal equipment. The inhibitor stabilizes these solutions, protects the equipment from corrosion, and prevents the reduction of the mercurial to metallic mercury.

Other uses of the inhibitor are now under study. An application for patent protection on the development has been filed.

CMU ANALYSES REQUIRE SPECIAL ATTENTION

An accurate method for the determination of CMU in soil and plant material specimens has recently been adapted for use in the Station laboratories. In this connection, it was found that the organic fractions of Hawaiian soils carry constituents which yield increments that add to the apparent concentration of the active constituent being sought in the specimen under examination. Therefore, it has been found necessary to analyze an untreated soil from a nearby area, or one which is of the same type, as a blank or check run. The findings accruing from the blank run are subtracted from the principal determination in order to reach an accurate figure for the amount of CMU present in the soil. Similar studies are in progress on other urea derivatives—PMU and DCMU.

METHYL BROMIDE USEFUL FOR CONTROL OF NUTGRASS

Methyl bromide was demonstrated to be valuable for eliminating nutgrass in small areas on the Experiment Station grounds. It completely eradicated nutgrass from the treated areas. A 24-hour exposure proved to be adequate where one pound of fumigant per 100 square feet was used under a vapor-proof cover. (Figures 64 and 65)

Methyl bromide is poisonous and, therefore, must be handled properly. The material used was Dowfume MC–2, which contains 98 per cent methyl bromide with 2 per cent chloropicrin added to give the gas an odor.

Methyl bromide and application kits are available from Pacific Chemical & Fertilizer Company, and a pamphlet of instructions is available from this Experiment Station.

CONTROLLING NUTGRASS WITH 2,4–D AND 2,4,5–T

Skirmish tests on nutgrass were conducted on the Experiment Station grounds using low-volatile esters of 2,4–D and 2,4,5–T.

The sodium salts (honocide) of 2,4,–D and 2,4,5–T, and the 2:1 mixture of the two, showed effectiveness as follows: 2,4–D was the most effective; the 2:1 mixture of 2,4–D + 2,4,5–T was next; and 2,4,5–T was the least effective.

The effectiveness seemed to be markedly better in the moist bottom of the cane line. The chemicals also were more effective when applied just prior to, or soon after, irrigation. The 2,4–D kept up with new plant development and has had an effect lasting 20 days after the final treatment. The exact number of treatments necessary for control will be determined by the moisture supply which is necessary to keep nutgrass in vigorous growth.

The low-volatile ester of 2,4–D at the rate of four pounds per gallon in one per cent concentration in water applications, spaced 10 to 14 days apart, killed all surface growth. Three applications seemed to be sufficient, though it is possible that a few dormant nutlets may germinate later. Here again, complete success cannot be attained if nutgrass is allowed to become dormant from lack of moisture at any time during the period of treatment.

The butoxy-ethoxy-proponol-ester 2,4,5–T applied at 10 and 20 gms per gallon showed a rapid

Figure 64. When methyl bromide is applied in treating nutgrass, it is introduced under an airtight cover. This area was treated January 12 to 14, 1954.

Figure 65. Nutgrass plants were completely eliminated from the areas treated with one pound of methyl bromide per 100 square feet and covered for 24 hours. This view was photographed on March 26, 1954, 73 days after treatment. Inspection on September 15, 1954, 246 days after treatment, showed that no nutgrass had survived within the area

kill for both concentrations. All above-ground plants were killed within three to five days after spraying. Laterals over a distance up to three nutlets were killed. It is possible that this was in part an inhibiting effect rather than a total kill.

As the problem of dormancy of nutgrass nutlets is the same with this chemical as with the others, complete elimination cannot be assured.

DRIFT HAZARDS OF 2,4,5–T, 3,4–D, DALAPON, CMU AND 2,4–D COMPARED

Several studies have been conducted in cooperation with the Board of Agriculture and Forestry to determine the hazards of drifting herbicides.

Tests with 2,4,5–T, 3,4–D, Dalapon, and CMU, in comparison with 2,4–D, have shown that all four are less hazardous than 2,4–D as follows:

1. Forms of 2,4–D sprayed at 15 gallons per acre at concentrations as low as five and 10 ppm have caused distortion of tomato, watermelon and papaya plants.

2. Higher levels of 50 to 100 ppm of 2,4,5–T at 15 gallons per acre were required before distortion was noted on tomatoes of the Pritchard variety.

3. CMU at 1000 ppm at 15 gallons per acre caused slight chlorosis of leaves and slight fruit distortion on Pritchard tomatoes. These symptoms did not appear at 500 ppm at the same gallonage.

4. A one per cent (10,000 ppm) solution of Dalapon caused burns on the leaf margins of the Rutgers tomatoes. Chlorotic areas were noted six days after treatment. Blossoming was delayed.

5. Tomato plants of the Rutgers variety were not affected by concentrations of 100 ppm of the honocide-type formulation of 3,4–D.

VOLATILITY STUDIES WITH 2,4–D AND 2,4,5–T

Greenhouse studies with the low- and high-volatile esters and amine salts of 2,4–D and 2,4,5–T have been conducted in cooperation with the Board of Agriculture and Forestry. These studies have shown that, when either of the above herbicides are sprayed on soil at dosages as high as 20 pounds in 15 gallons of aromatic oil per acre, volatile fumes can arise that will cause distortion of tomato, papaya and macadamia plants. *Caution is therefore urged in using these materials in the vicinity of susceptible crop plants.*

Other herbicides, such as CMU and TCA, are recommended for pre-emergence weed control in areas of potential hazard.

PRE-EMERGENCE CONTROL OF KOA HAOLE WITH CMU

In cooperation with the Board of Agriculture and Forestry, a cleared area in the Makiki nursery of the Forestry Division was treated with CMU alone, with a combination of CMU and sodium arsenite spray, and with the arsenite alone. CMU was used primarily to study its pre-emergence effect on koa haole (*Leucaena glauca*).

CMU was applied at the rates of 13 pounds and three pounds per acre in combination with sodium arsenite (Penite 6). A few days after the application, nearly all of the seedlings and other surface growth were killed. Wet weather following the treatment greatly increased seed germination over the entire area. In the area which received an application of 13 pounds of CMU, these new seedlings soon became chlorotic and died. Five weeks after the spray application, the control of seedlings, chiefly koa haole, was good. Stumps of koa haole, however, were not killed, but exhibited two feet of regrowth. Control at this dosage was poor on grasses and plants with deep underground runners or with storage roots.

Pre-emergence control in the area receiving three pounds CMU was poor.

Pre-emergence and general weed control in areas treated with a combination spray of three pounds CMU and sodium arsenite looked no better than in areas treated with sodium arsenite alone.

About four weeks after the application, the area was planted with ornamental trees. These trees showed no ill effects.

These tests indicate that the application of 13 pounds of CMU per acre will give good pre-emergence control of koa haole and other pests without injuring young transplanted trees. CMU may be profitably used in all areas where there are heavy accumulations of undesirable, viable seeds.

Figure 66. Dalapon at the rate of 10 pounds per acre sprayed over the cane plant inhibits the growing point, resulting in lalas from the lower nodes. Dalapon must be handled carefully to avoid such results. Repeated applications of low dosage, 2.5 to 5 pounds per acre, appear practical, when they are selectively directed.

Figure 67. The treated plot of manienie grass at Waialua received four applications of Dalapon at 2.5 pounds per acre, at four-week intervals. These split treatments, totalling 10 pounds per acre, have almost completely eradicated the manienie. Broad-leaved weeds are emerging where the grass has been destroyed. The check area is in the foreground.

DALAPON PROVES EFFECTIVE ON GRASSES

Dalapon has been tested on several plantations, in amounts ranging from one to 20 pounds per acre, with satisfactory results in most cases. It has been found that *Panicum repens* on the Hilo Coast can be controlled with three applications of two pounds per acre with no damage to the cane. Two four-pound applications at three-week intervals have shown damage, as has one six-pound application, but as yet no damage has been noticed from three two-pound applications.

Two pounds per acre of Dalapon affects *Panicum repens* much as 15 pounds of TCA does, in that it causes a distortion of the growing point. It differs from TCA in that it does not burn the leaves but affects the terminal growing points first, causing a stimulation of all growth buds followed by severe distortion and die-back.

Dalapon is slow-acting so that distortion does not show up until about the second week after spraying. Die-back occurs around the 50th day, or 30 days after the second application. This second application will hold from 60 to 70 days, with the third going on at around 100 days.

Heavier amounts, 10 pounds per acre and up, have given 75 to 80 days of control with a single application, but at the same time have caused a setback in cane growth. (Figure 66) A second heavy application has caused severe damage to the cane, forcing it to lala at every node and distorting and twisting the terminal growth point to such an extent that the stalk either stopped growing for about two months or died completely.

The best time to apply Dalapon seems to be when the grass is two to three inches high or in early vegetative stage. The timing of the second application seems very important. When using low amounts of Dalapon, it is necessary to re-treat at an interval of 20 to 30 days in order to gain complete control, after which the interval can be extended up to 50 or 60 days.

At present, one of the main interests is in the combination of Dalapon and TCA which looks promising. A combination of six pounds of TCA and one pound of Dalapon applied twice 21 days apart, gave excellent control of *Panicum repens* for 67 days with no visible signs of new growth. The

Figure 68. The two rows of cane on the left show damage due to faulty application of CMU by spray gang. Close supervision, accurate calibration and careful application are required in using CMU in order to prevent damage, especially when CMU is suspended in a contact agent. Proper application has proved more difficult to achieve with spray gangs than with either aircraft or tractors.

grass was completely dried up and appeared dead.

Repeated applications of 2.5 pounds of Dalapon have proved effective on manienie at Waialua. With four applications, nearly complete kills of manienie have resulted. (Figure 67)

Tall panicum sprayed once with 20 pounds of Dalapon was kept under good control along the roadside at Kahuku for 84 days. Application of 10 pounds per acre was not effective on this grass.

Repeat treatments of 2.5 pounds of Dalapon per acre for totals of 15, 20 and 25 pounds, gave over 133 days of control on tall panicum at Lihue.

APPLY CMU PROPERLY

After approximately two years of field-scale use of CMU for weed control, it may be well to re-emphasize a few points with regard to its proper application.

1. CMU is of low solubility, consequently it must be applied as a wettable powder. This can be done either through suspension in a liquid medium of proper viscosity to prevent settling, or through continuous agitation in the carrier liquid. CMU in pellet form has proved successful for some purposes.

2. The more common methods of application are by airplane, tractor or knapsack spraying, with uniformity of application and consequent prevention of damage to sugar cane by over-application in that order. Airplane application has proved the least, and spray-gang application the most, damaging. (Figure 68) This may be due in part to the fact that, when CMU is suspended in a contact agent such as CADE, over-application of the CMU has resulted from the natural tendency of the spray men to drench weeds in order to kill them. For this reason, single-nozzle spot application of CMU should be avoided. Calibration should be based on a uniform nozzle speed over the ground. This should be true of all modes of application—airplane, tractor, or spray gang.

In order to prevent over-application, tractor units should shut off the spray while turning at field borders and while standing in the field.

3. Agitators should be installed in the storage tanks of airplane and tractor units for use whenever suspension of wettable powders or mixing of solutions is needed. Field supply tanks for spray gang operations should also be equipped with agitation systems.

4. Proper agitation of wettable powders in knapsacks is presently under study.

SOILS STUDIED FOR RESIDUAL CMU

In order to determine whether a residue of CMU can build up in soil to such an extent that it will become toxic to sugar cane, analytical studies have been initiated on plantation soils in cooperation with the du Pont Company, manufacturers of CMU, Pacific Chemical & Fertilizer Company, the CMU distributors in Hawaii, Island Representatives, and plantations.

For a time, analyses were conducted in the laboratories of the Department of Chemistry at the Station. Results reported here are from these studies.

Recently, the du Pont Company sent one of their chemists, Dr. H. M. Baker, to the Islands to concentrate on this problem. When the results of joint studies with du Pont are made known, they should be of great value in determining the possibility of building up the toxic levels of CMU in the soil.

From the information presently at hand, a few general statements may be made:

1. Under the high rainfall (unirrigated) conditions of the Hilo-Hamakua Coast and Olaa, low levels of CMU have remained in the soil 20 months after application. At Paauhau Sugar Plantation Company, low levels remained after five months. These soils are classified as humic latosols and hydrol humic latosols.

2. Under low rainfall (irrigated) conditions on the low humic latosols on Oahu and Kauai, damage to cane has resulted at the ends of irrigation lines and from apparent over-application. Analyses for CMU in these areas have shown a relatively high residual, especially in the surface soil. It should be emphasized that the longest periods of weed control have been observed on the red soils in the low humic latosol families.

3. With few exceptions, the greatest concentration of CMU is in the surface soil (0–3 inches). Concentrations at the three- to six-inch level have run markedly lower.

YIELD DECLINE

An interdepartmental project was set up in an effort to determine what factors may be responsible for yield decline in sugar cane varieties. The cooperating departments are: Agronomy, Entomology, Experimental Statistics, Genetics, Pathology, and Physiology and Biochemistry.

The project is being studied and attacked from several approaches.

NO EFFECT OF ROTATING VARIETIES

In 1952, two Grade A tests were undertaken in cooperation with Lihue to compare the relative influences on yield decline of two planting systems: varietal succession, where one variety is planted in the same field year after year; and varietal rotation, where two or more varieties are planted alternately. Two large plots, originally occupied by 37–1933 and 32–8560, respectively, were split into small plots and planted in the following patterns:

Variety Succession	Variety Rotation
37–1933 following 37–1933	37–1933 following 32–8560
32–8560 following 32–8560	32–8560 following 37–1933

No differences in sugar yields between the two practices were obtained in the plant crop, which was harvested in June 1954.

IMPORTANT FIELD EXPERIMENTS STARTED

To appraise the influence on yield decline of soil improvement with composted organic matter as well as soil treatments with DD and with Chlordane to control soil-borne diseases and insects, two Grade A tests have been installed. The first, under irrigated conditions at Oahu Sugar, and the second, under unirrigated conditions at Hamakua Mill Company, were installed to determine the possibility of bringing back the sugar yields of varieties which have shown symptoms of yield decline, as well as to discover whether or not sugar yields of varieties which have not shown symptoms of yield decline can be maintained over a period of years. The varieties planted were H109 and 32–8560, which have shown yield decline, and 37–1933 and 44–3098, which have not. H109 and 37–1933 were planted at Oahu Sugar, 32–8560 and 44–3098 at Hamakua. The biological, chemical, physical, and environmental factors which may be responsible for any yield decline in these tests are being investigated.

All planting material for these tests was taken from disease-free seed sources, grown at Waipio from cuttings given the LHWT prior to planting.

Compost was added at the rate of 15 tons per acre. DD and Chlordane were applied at the rates of 400 and 5 pounds per acre, respectively, and produced rather strikingly beneficial results in early growth.

Chlordane and DDT, in amounts of five pounds per acre, either mixed with the upper six inches of soil before planting or applied on the seed pieces in the furrow before covering, produced a high percentage of uninjured roots and a smaller number of pits per inch of root than occurred in areas where the soils had not been treated. Dosages as high as 40 pounds per acre, mixed with the soil, had no ill effects on cane growth.

POT CULTURES INDICATE DEPRESSED GROWTH OF 37–1933

Yield decline, as indicated by depressed growth of 37–1933 and to a lesser degree of 44–3098, 32–8560 and H109, has occurred in pot studies at the Pathology Plot. (Figure 69) These varieties are being grown in steam-sterilized and unsterilized Makiki soil which has not been inoculated and

Figure 69. 37–1933, 5.5 months old, is shown growing in unsterilized (U) Makiki soil at the Pathology Plot. Note the depressed growth in the three pots on the right, where the soil was inoculated with a composite soil inoculum (U-1) collected from poor growth areas on Kauai, Oahu and Hawaii.

which has been inoculated with a composite soil inoculum collected from poor cane growth areas on Kauai, Oahu, and Hawaii.

The factor or factors responsible for the depressed growth appear to be biological in nature since only a small amount of inoculum was used for each pot. Growth in the uninoculated pots appears normal.

In additional tests, each soil which went into the preparation of the composite inoculum will be used as a separate inoculum in order to pinpoint the exact location of the "sick soil". As soon as this is determined, the soil will be treated, chiefly with fumigants, in an effort to control possible soil pathogens which may be causing the growth failure.

MEALYBUGS NOT AFFECTED BY SYSTEMIC INSECTICIDES

Attempts were made by the Department of Entomology to eliminate mealybugs from field cane in order to measure losses due to their presence. "Schradan" and "Systox", systemic insecticides effective against various pests on broad-leaved plants, were not effective against mealybugs on sugar cane, even at strengths which killed the plants. No single-application treatment is available at present which will free cane of mealybugs for the period of 24 months required by the Yield Decline experiments.

Cane from seed pieces free of mealybugs became infested in the field within three months after planting. No differences in germination or growth were apparent between plantings from mealybug-free, and from heavily-infested seed pieces.

HEAT TREATMENT OF CUTTINGS AS A MEANS OF FORESTALLING YIELD DECLINE

The effect of heat treatment of cuttings as a means of forestalling varietal yield decline is being investigated by the Pathology Department.

It has been demonstrated that the LHWT controls ratoon stunting disease and may possibly prevent the transmission of other systemic diseases which may play a role in the yield decline problem. The disease-free nurseries now established on most plantations and at the variety stations will aid in determining whether or not the heat treatment of cuttings is an effective measure for preventing yield decline.

TRAINING PLANTATION PERSONNEL

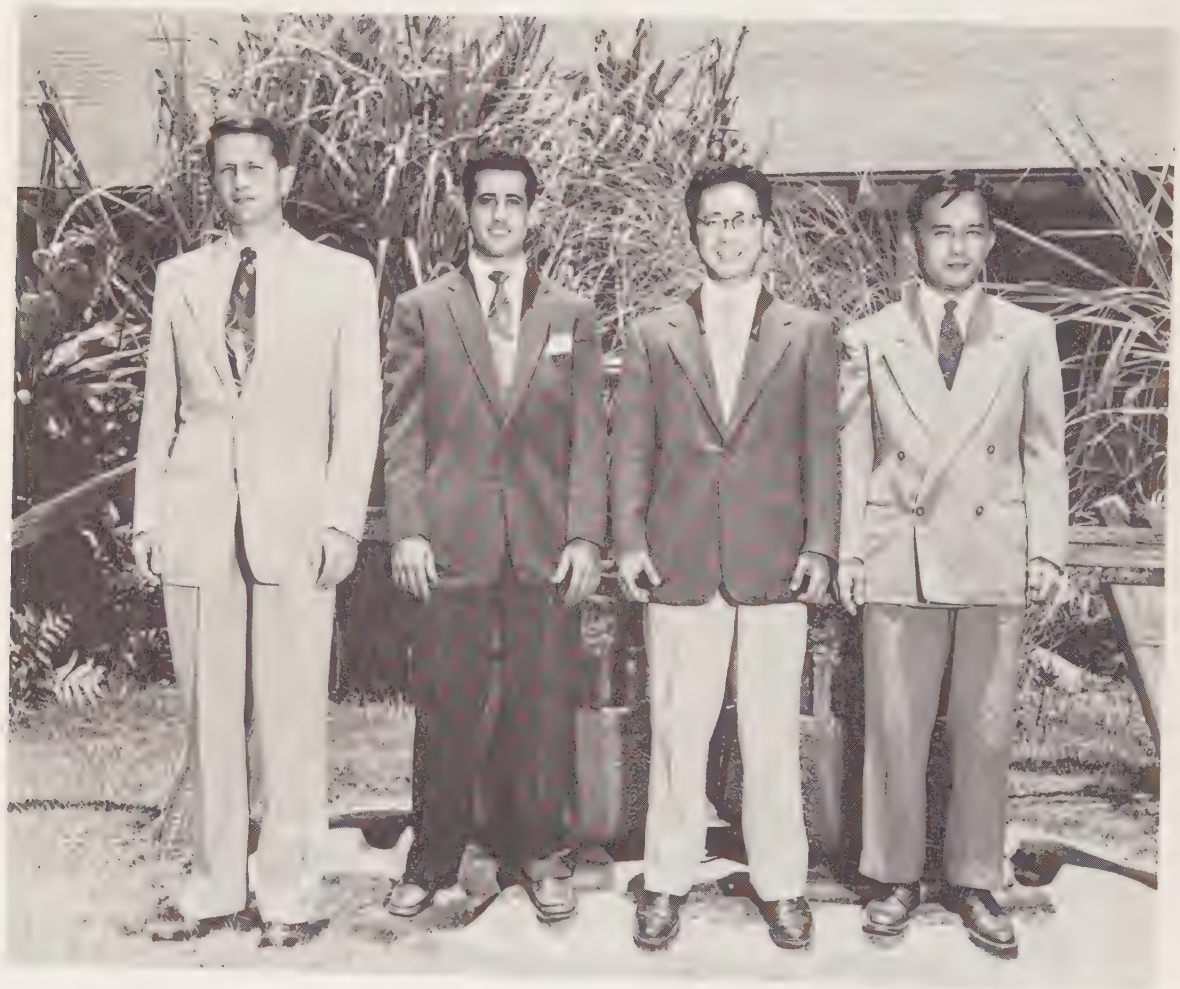


Figure 70. Assistants-in-Training in Sugar Factory Technology, 1954–1955: Robert Freeman, Gilbert Fernandes, Wallace Hirai and Lawrence Iwami.

Figure 71. Assistants-in-Training in Agriculture, 1954–1955: W. K. Brand, George Murphy, Kenichi Kunimitsu, James Russell, Theodore Sparrow, Daniel Dereschuk, Donald Wilton and J. W. Siemer. Inset: A. W. Duvel, Jr.

EXPERIMENT STATION STAFF

ADMINISTRATION

L. D. Baver ..... *Director*
H. L. Lyon ..... *Consultant*

Business Office

A. R. Grammer ..... *Senior Office Manager*
F. Wm. Littlejohn ..... *Associate Office Manager*

Publications and Visual Aids

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R. J. Leffingwell ..... *Consultant*
Lydia C. Nickerson ..... *Associate Editor*
J. T. Yamamoto ..... *Photographer and Illustrator*

Library

Mabel Fraser ..... *Senior Librarian*
Jean Dabagh ..... *Assistant Librarian*

Buildings and Grounds

William Sa Ning ..... *Superintendent*

Island Representatives

HAWAII

O. H. Lyman ..... *Senior Island Representative*
K. L. Bond ..... *Assistant Island Representative*
A. Sato ..... *Substation Overseer*
H. Miyamoto ..... *Substation Assistant*
H. Oba ..... *Substation Assistant*
Y. Sugawara ..... *Substation Assistant*

OAHU

F. C. Denison ..... *Senior Island Representative*
J. B. Menardi ..... *Associate Island Representative*
B. K. Nishimoto ..... *Substation Overseer*
J. Bumanglag ..... *Substation Assistant*
L. Nakatsuka ..... *Substation Assistant*
C. G. Suero ..... *Substation Assistant*

KAUAI

D. S. Judd ..... *Senior Island Representative*
Y. Inouye ..... *Substation Overseer*
A. T. Togikawa ..... *Substation Assistant*

AGRICULTURAL ENGINEERING

R. A. Duncan ..... *Principal Agricultural Engineer*
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J. M. Nutter ..... *Associate Agricultural Engineer*
W. J. Tempas ..... *Associate Agricultural Engineer*
T. Adachi ..... *Associate Engineer*
D. M. Burns ..... *Associate Agricultural Engineer*
E. M. Norum ..... *Associate Agricultural Engineer*
S. Matsuoka ..... *Assistant Mechanical Engineer*
G. S. Palmerton ..... *Assistant Mechanical Engineer*
Y. Isa ..... *Mechanic*
C. K. Mahoe ..... *Mechanic*
K. Togashi ..... *Machinist*
E. T. Torricer ..... *Mechanic*

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R. B. Campbell ..... *Senior Agronomist*
N. S. Hanson ..... *Senior Agronomist*
A. H. Cornelison ..... *Associate Agronomist*
R. E. Doty ..... *Associate Agronomist*
A. C. Trouse, Jr. ..... *Associate Agronomist*
H. Hagihara ..... *Assistant Agronomist*
T. A. Jones ..... *Assistant Agronomist*
J. A. Silva ..... *Assistant Agronomist*
H. Asato ..... *Agronomy Assistant*
A. Y. Ching ..... *Agronomy Assistant*
W. T. Goto ..... *Agronomy Assistant*
Y. Yamasaki ..... *Agronomy Assistant*

BOTANY

H. L. Lyon ..... *Botanist*
Colin Potter ..... *Nursery Superintendent*

BY-PRODUCTS

G. W. Aljian ..... *Coordinator*
T. J. Nelson ..... *Consultant*
W. A. Robinson ..... *Sr. Pulp & Paper Technol.*
R. W. F. Morel ..... *Senior Chemical Engineer*
S. B. Knapp ..... *Assoc. Pulp & Paper Tech.*
T. Yamamoto ..... *Assistant Technologist*
M. Amaki ..... *Pilot Plant Technician*

CHEMISTRY

F. E. Hance ..... *Principal Chemist*
Richard Boyen ..... *Executive Assistant*
Q. H. Yuen ..... *Senior Chemist*
M. Doi ..... *Associate Chemist*
G. C. Battle, Jr. ..... *Assistant Chemist*
T. S. Jones ..... *Assistant Chemist*
H. M. Lee ..... *Assistant Chemist*
George Uyehara ..... *Assistant Chemist*
George Koizumi ..... *RCM Technician*
Henry Mau ..... *Analyst*
C. T. Nakagawa ..... *Laboratory Technician*
E. S. Yamamoto ..... *Laboratory Technician*

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R. H. Van Zwaluwenburg ..... *Principal Entomologist*
F. A. Bianchi ..... *Senior Entomologist*
J. W. Beardsley, Jr. ..... *Assistant Entomologist*
J. S. Rosa ..... *Laboratory Technician*

EXPERIMENTAL STATISTICS

R. K. Tanaka ..... *Assistant Statistician*

GENETICS

A. J. Mangelsdorf ..... *Principal Geneticist*

J. N. Warner ..... *Senior Geneticist*
Samuel Price ..... *Associate Geneticist (Co-op. U.S.D.A.)*
R. Urata ..... *Associate Geneticist*
A. Doi ..... *Assistant Geneticist*
M. Tanaka ..... *Supt. Kailua Field Laboratory*
R. Chi ..... *Genetics Assistant*
N. Kimura ..... *Genetics Assistant*
K. Nishimoto ..... *Genetics Assistant*
K. Sadanaga ..... *Genetics Assistant*
H. Terayama ..... *Genetics Assistant*

GEOLOGY

D. C. Cox ..... *Senior Geologist*

METEOROLOGY

W. A. Mordy ..... *Meteorologist (Co-op. with PRI)*
T. Hayashi ..... *Laboratory Technician*
Gordon Furmidge ..... *Assistant Meteorologist, Instrument Specialist*

PATHOLOGY

J. P. Martin ..... *Principal Pathologist*

C. A. Wismer ..... *Senior Pathologist*
H. Koike ..... *Assistant Pathologist*

PHYSIOLOGY AND BIOCHEMISTRY

G. O. Burr ..... *Principal Physiologist and Biochemist*

H. W. Brodie ..... *Senior Physiologist*
Constance E. Hartt ..... *Associate Physiologist*
H. P. Kortschak ..... *Associate Biochemist*
T. Tanimoto ..... *Associate Biochemist*
F. M. Ashton ..... *Assistant Biochemist*
Robert E. Coleman ..... *Assistant Physiologist (Co-op. U.S.D.A.)*
Ada Forbes ..... *Assistant Physiologist*
David Takahashi ..... *Assistant Biochemist*
Mary Ann Koenig ..... *Laboratory Technician*

SUGAR TECHNOLOGY

J. H. Payne ..... *Principal Technologist*
G. E. Sloane ..... *Senior Technologist*
R. K. Hamilton ..... *Associate Technologist*
H. I. Mahon ..... *Associate Technologist*
L. J. Rhodes ..... *Associate Technologist*
F. J. Dupin ..... *Scale Inspector*
A. C. Fong ..... *Laboratory Technician*
H. S. Iwata ..... *Laboratory Technician*
Ray Spellman ..... *Laboratory Technician*
E. S. S. Lam ..... *Laboratory Technician*

TRAINING OF PERSONNEL

W. P. Alexander ..... *Principal Coordinator*

Assistants-In-Training

AGRICULTURE

R. T. F. Aea
W. K. Brand
D. Dereschuk
A. W. Duvel, Jr.
R. P. Gagner
J. C. Hance
H. H. Hoshide
K. Kunimitsu
G. M. Murphy
H. L. Rubin
J. A. Russell
J. W. Siemer
T. R. Sparrow, Jr.
F. E. Trotter
R. T. Vorfeld
D. P. Wilton

SUGAR TECHNOLOGY

M. H. Caplin
G. N. Fernandes
R. E. Freeman
W. A. Hirai
N. L. Iwami
M. Y. Lum
M. K. Thompson

STATION PERSONNEL CHANGES

October 1, 1953 — September 30, 1954

Joined the Staff

Alexander, W. P.	*Principal Coordinator*	Training Personnel
Beardsley, J. W., Jr.	*Assistant Entomologist*	Entomology
Brand, W. K.	*Assistant-in-Training*	Training Personnel
Dereschuk, D.	*Assistant-in-Training*	Training Personnel
Duvel, A. W., Jr.	*Assistant-in-Training*	Training Personnel
Fernandes, G. N.	*Assistant-in-Training*	Training Personnel
Freeman, R. E.	*Assistant-in-Training*	Training Personnel
Hirai, W. A.	*Assistant-in-Training*	Training Personnel
Iwami, N. L.	*Assistant-in-Training*	Training Personnel
Kunimitsu, K.	*Assistant-in-Training*	Training Personnel
Lam, E. S. S.	*Laboratory Technician*	Sugar Technology
Miyamoto, H.	*Substation Assistant*	Hawaii Substation
Murphy, G. M.	*Assistant-in-Training*	Training Personnel
Palmerton, G. S.	*Assistant Mechanical Engineer*	Agricultural Engineering
Russell, J. A.	*Assistant-in-Training*	Training Personnel
Siemer, J. W.	*Assistant-in-Training*	Training Personnel
Sparrow, T. R., Jr.	*Assistant-in-Training*	Training Personnel
Wilton, D. P.	*Assistant-in-Training*	Training Personnel

Left the Staff

Bond, C. H.	*Assistant-in-Training*	Training Personnel
Crittenden, W. J.	*Assistant-in-Training*	Training Personnel
Kono, T.	*Assistant-in-Training*	Training Personnel
Moniz, D..	*Substation Assistant*	Hawaii Substation
O'Brien, T. J.	*Assistant-in-Training*	Training Personnel
Ogasawara, E. T.	*Assistant-in-Training*	Training Personnel
Ooka, S. T.	*Assistant-in-Training*	Training Personnel
Rogers, A. G.	*Assistant-in-Training*	Training Personnel
Ushigome, T.	*Machinist*	Agricultural Engineering
Van Zwalenburg, P. R.	*Assistant-in-Training*	Training Personnel
Wagoner, H. E.	*Assistant-in-Training*	Training Personnel
Wakatsuki, W. R.	*Laboratory Technician*	Sugar Technology
Winans, R. J.	*Assistant-in-Training*	Training Personnel
Wright, W. R.	*Assistant-in-Training*	Training Personnel
Zimmerman, E. C.	*Associate Entomologist*	Entomology

On Leave of Absence for Military Duty

May, C. W., Jr.	*Assistant-in-Training*	Training Personnel
Nelson, Victor J.	*Assistant-in-Training*	Training Personnel

Retired

Chun, Edwin	*Field Foreman*	Makiki Buildings & Grounds
Hansen, A. K	*Senior Design Engineer*	Agricultural Engineering
Lamb, A. R.	*Associate Biochemist*	Physiology & Biochemistry
Pemberton, C. E.	*Principal Entomologist*	Entomology

Deceased

Borden, Ralph J.	*Principal Statistician*	Experimental Statistics
Victoria, Pedro	*Drafting Technician*	Experimental Statistics

1954 REPORT

EXPERIMENT STATION COMMITTEE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION